TO 31R2-2PRC139-1

OPERATION AND MAINTENANCE INSTRUCTIONS WITH ILLUSTRATED PARTS BREAKDOWN

ORGANIZATIONAL LEVEL

RADIO SET AN/PRC-139(C)
(HAND-HELD RADIO)
INCLUDING RECEIVER-TRANSMITTER SET, RADIO RT-1695/TRC199, RECEIVER-TRANSMITTER SET, RADIO RT-1696/U(C), PROGRAMMER UNIT, FREQUENCY, RADIO MX-11531/U, (FREQUENCY FILL DEVICE), BATTERY CHARGERS AND BATTERY RECONDITIONER

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SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedure, and do not appear elsewhere in this manual. These Safety Summaries are recommended precautions that all personnel must understand and apply during any given phase of operation and maintenance. Each chapter has other specific warnings and cautions.

WARNING

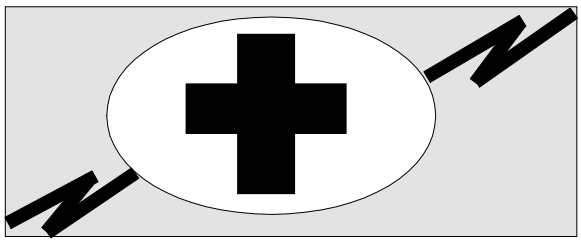
KEEP AWAY FROM LIVE CIRCUITS

Personnel must at all times observe all safety regulations. Do not replace components or make adjustments inside equipment with power turned on. Under certain conditions, dangerous potentials may exist when the power switch is in the off position due to charges retained by capacitors. To avoid injury, always remove power and discharge and ground a circuit before touching it.

WARNING

Do not operate the AN/PRC-139(C) or charge batteries within 10 feet of fuel vent. This could result in an explosion.

WARNING



LITHIUM BATTERIES

Lithium oxide batteries may be used in this equipment. They are potentially hazardous if misused or tampered with before, during or after discharge. The following precautions must be strictly observed to prevent possible injury to personnel or equipment damage.

Do not heat, incinerate, crush, puncture, disassemble, or otherwise mutilate the batteries.

Do not short-circuit, recharge, or bypass internal fuse.

Do not store batteries in equipment during long periods of non-use (in excess of 30 days).

Turn off the equipment immediately if you detect battery compartment becoming unduly hot, hear battery cells venting (hissing sounds), or smell irritating sulfur dioxide gas.

RESUSCITATION

Personnel working with or near high voltages should be familiar with modern methods of resuscitation. Such information may be obtained from the Director of Base Medical Services.

Page

4-8 WARNING - Do not change battery within 10 feet of open fuel/fuel vents or operate the radio within 10 feet of aircraft fuel vent outlets, open port refueling receptacles, or fuel spills.

2-1 CAUTION - Exercise care when removing from packing material in order to prevent damage to the unit.

3-2 CAUTION - Never apply pressure sensitive tape directly to connectors. This could damage connector pins.

3-2 CAUTION - Package all ESD sensitive assemblies in ESD bags before shipping or storing.

Page

3-2 CAUTION - Rough handling may cause damage to electronic assemblies.

3-2 CAUTION - Electronic assemblies containing solid-state devices are susceptible to damage from static electrical discharges. Place items in ESD bags. Wear protective clothing and grounded wrist straps.

3-2 CAUTION - Forcing any misaligned electronic assembly into position may result in bent or broken pins.

3-3 CAUTION - When replacing an electronic assembly, be careful that the tool employed does not inadvertently press against leads, pins, or other parts that are easily bent.

3-3 CAUTION - When handling an assembly that has been removed from its chassis, be careful not to press against the leads and pins. When removing an assembly, be sure to pull it straight out from the equipment. Do not cock, twist, pry, or carelessly jerk an electronic assembly to remove it from the mounting or connector.

3-3 CAUTION - The hand-held radio contains components that are susceptible to damage by static electrical charges. Disassembly of the hand-held radio should only be done at a properly grounded work station.

4-12 CAUTION - Take care not to pull the multiple punched hole section of the tape through at this time.

6-10 CAUTION - Use care in removing and replacing modules and CCAs to prevent damage to pins and sockets.

6-10 CAUTION - The modules and CCAs in the receiver-transmitter contain parts that are sensitive to damage by electrostatic discharge (ESD). Use ESD precautionary procedures (wear grounding wrist straps) when touching, removing, and installing the module.

6-10 CAUTION - Before performing removal/replacement procedures, make sure the hand-held radio is powered down and the battery is removed from the hand-held radio. Failure to do so could result in equipment damage.

6-11 CAUTION - Turn off power before removing the battery by setting the volume switch to the OFF position. Failure to do so can result in damage to the receiver-transmitter.

6-12 CAUTION - The receiver-transmitter contains components that are susceptible to damage by static electrical charges. Disassembly of the receiver-transmitter should only be done at a properly grounded work station.

6-12 CAUTION - Before performing removal/replacement procedures, make sure the hand-held radio is powered down and the battery is removed. Failure to do so could result in equipment damage.

A3-4 CAUTION - Use care in removing and replacing modules to prevent damage to pins and sockets.

A3-4 CAUTION - The CCA in the frequency fill device contain parts that are sensitive to damage by electrostatic discharge (ESD). Use ESD precautionary procedures (wear grounding wrist straps) when touching, removing, and installing the module.

FOREWORD

This manual meets the technical content requirements of specification MIL-M-38798B, paragraph 3.3 (1 December 1975) and MIL-M-38807 (1 June 1982) and format requirements of specification MIL-M-38784B (16 April 1983) for the receiver-transmitter.

a. Chapter 1 - General Information. This chapter provides general information for the receiver-transmitter including equipment description and purpose, leading particulars, capabilities and limitations, equipment supplied, equipment required but not supplied, optional equipment, special tools and test equipment, and related technical manuals.

b. Chapter 2 - Installation. This chapter provides complete installation instructions for the receiver-transmitter including installation logistics and installation procedure.

c. Chapter 3 - Preparation for Use and Reshipment. This chapter contains information which will permit operation and maintenance personnel to prepare the equipment for use, including reference to post-installation checkout procedures, preparing the unit for reshipment, packing, handling, and storage procedures.

d. Chapter 4 - Operation. This chapter provides complete operating instructions for the receiver-transmitter.

e. Chapter 5 - Theory of Operation. This chapter provides complete theory of operation for the receiver-transmitter.

f. Chapter 6 - Maintenance. This chapter provides all instructions required for on-equipment and off-equipment maintenance of the receiver-transmitter. Includes preventive maintenance, troubleshooting procedures, and repair procedures.

g. Chapter 7 - Illustrated Parts Breakdown (IPB). Provides complete illustrated parts breakdown for the receiver-transmitter. The IPB is prepared in accordance with MIL-M-38807A.

h. Chapter 8 - Circuit Diagrams. Contains interconnection diagrams and functional block diagrams.

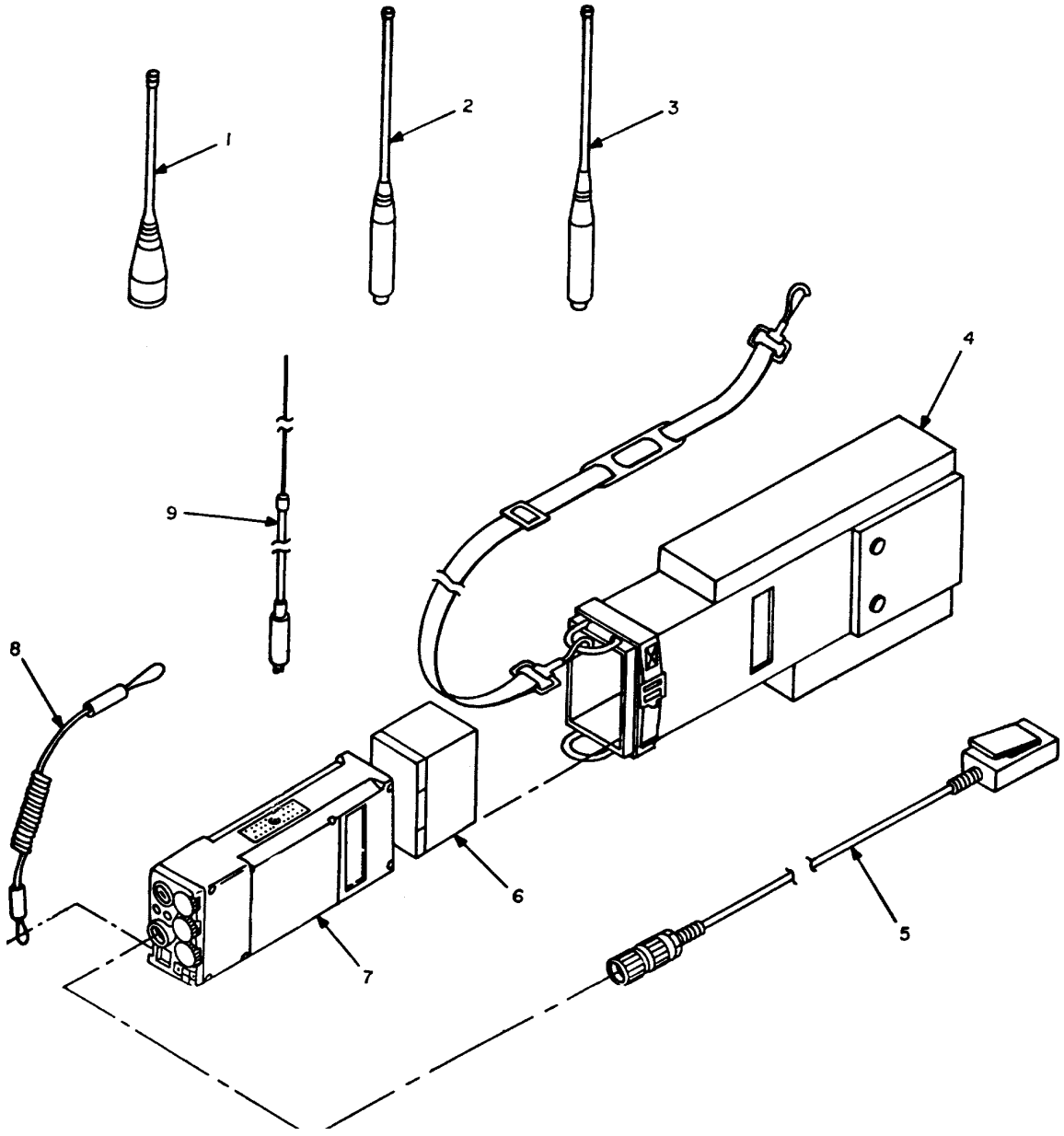
i. Glossary - Provides a definition of the special terms and abbreviations used in the technical order.

j. Alphabetical Index - Provides cross-references to applicable paragraphs, figures or tables.

k. Appendix A - Provides operation and maintenance instructions for the Programmer Unit, Frequency, Radio MX-11531/U (frequency fill device).

l. Appendix B - Provides operation and maintenance instructions for the single station and multiple station battery chargers.

m. Appendix C - Provides specific instruction on Communications Security (COMSEC) considerations for handling and operating the radio.



Legend

1. Antenna, Whip Helical, 403-470 MHz
2. Antenna, Whip Helical, 136-174 MHz
3. Antenna, Whip Helical, 30-88 MHz
4. Carrying Bag, Camouflage
5. Handset, Palm
6. Rechargeable Battery
7. Receiver-Transmitter Set, Radio RT-1696/U(C)
8. Lanyard
9. Antenna, 1 Meter Whip, 30-88 MHz

Figure 1-1. Radio Set AN/PRC-139(C)

CHAPTER 1. GENERAL INFORMATION

1-1 DESCRIPTION AND PURPOSE.

1-1.1 Equipment Function and Purpose.

Radio Set AN/PRC-139(C) (hereinafter referred to as the handheld radio) provides two-way (transmit and receive) communications in the 30-88, 136-174, or 403-470 Megahertz (MHz) frequency bands. Communication can be in either secure or non-secure modes. This technical order (TO) describes the operation and maintenance of the frequency modulated (FM) hand-held radio; Programmer Unit, Frequency, Radio MX-11531/U (hereinafter referred to as the frequency fill device); the single and multiple station battery chargers; . For information on Radio Set AN/GRC-238 (base station), Radio Set AN/TRC-199 (tactical repeater), or Adapter Group, Radio OF-228/U (vehicle adapter), reference the applicable TO listed in paragraph 1-7.

The handheld radio is interoperable with the AN/PRC-77, AN/PRC-128, and very high frequency (VHF) FM single channel mode of SINCGARS-V, VINSON (KY-57) compatible 16 kilobits/second (kbps) and FED-STD-1023 compatible 12 kbps receiver-transmitters. It is also interoperable with commercial 25 kHz analog (clear) FM equipment in all frequency bands and 12.5 kHz analog (clear) FM equipment in the 136-174 and 403-470 MHz bands.

1-1.2 Equipment Description.

(See Figure 1-1.) Radio Set AN/PRC-139(C) includes a Radio Receiver-Transmitter Set RT-1696/U(C), two rechargeable batteries, four interchangeable antennas, audio accessories, camouflage carrying bag, duty carrying bag, and lanyard. These items are described in detail in paragraphs 1-1.2.1 through 1-1.2.6. Additional equipment available for use with the hand-held radio is described in paragraphs 1-1.2.7 through 1-1.2.9.

1-1.2.1 Radio Receiver-Transmitter Sets RT-1696/U(C) and RT-1695/TRC-199.

(See Figure 1-2.) The Radio Receiver-Transmitter Set RT-1696/U(C) (hereinafter referred to as the receiver-transmitter) uses modular construction for ease of maintenance. It includes three interchangeable transceiver modules and a hand-held radio chassis. The transceiver module is enclosed within the rear cover assembly. Use of the interchangeable transceiver modules provides the capability of operating at all frequencies within the 30-88 (tactical), 136-174 (high), or 403-470 (ultra-high frequency (UHF)) MHz frequency bands. The operating band of the receiver-transmitter is determined by the transceiver module installed. When the transceiver modules are changed, the receiver-transmitter must be fitted with the proper antenna. The proper configurations are listed in Table 1-1.

The receiver-transmitter operates either as a stand-alone unit or as part of a Radio Set AN/GRC-238 (base station) or Adapter Group, Radio OF-228/U (vehicle adapter). The receiver-transmitter is used with a base station or vehicle adapter, as applicable, to provide increased transmit power, capability of operating from either alternating current (AC) or direct current (DC) power source, and use in a variety of vehicles.

A non-CCI receiver-transmitter, designated the RT-1695/TRC-199, is used in the tactical repeater. The tactical repeater is used to provide additional broadcast range. Both receiver-transmitters are identical except the RT-1696/U(C) is fitted with an INDICTOR COMSEC encryption/decryption integrated circuit. *The RT-1696/U(C) shall not be used in the tactical repeater.* The RT-1695/TRC-199 and the RT-1696/U(C) receiver-transmitters have different notches on the battery connector plate on the base. The notch on the RT-1695/TRC-199 mates with a corresponding post at the back of the sleeves in the tactical repeater. This prevents installation of the controlled cryptographic item (CCI) RT-1696/U(C) in the tactical repeater.

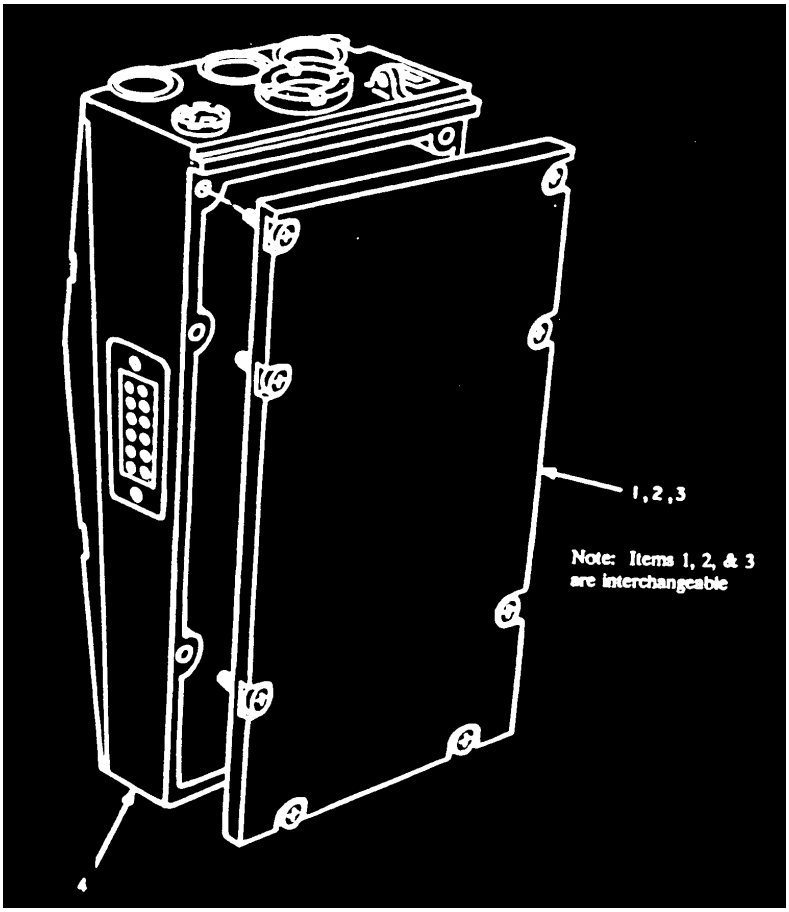
1-1.2.2 Antenna Assembly.

The antenna assembly for the receiver-transmitter provides transmit and receive capability. The antenna assembly provides transmit and receive frequency coverage in three bands of operation. As shown in Table 1-1, four antennas are provided to cover the three bands of operation.

The 1 meter antenna for the 30-88 MHz band provides greater gain than the helical whip antenna but is longer. The 30-88 MHz helical whip antenna is specifically designed for an operating range of 3 km or less; when operating at the lower end of the frequency band, the effective range may be even further reduced.

Table 1-1. Receiver-Transmitter Configuration Vs Frequency Band

Frequency Band	Receiver-Transmitter Transceiver Module	Antenna
30-88 MHz	SS-4100820-501	CAF25422, Antenna, Whip Helical SS-2100334-501, Antenna, 1 Meter
136-174 MHz	SS-4100821-501	SS-1600293-1, Antenna, Whip Helical
403-470 MHz	SS-4100822-501	CAF26165, Antenna, Whip Helical



Legend for Figure 1-2
1, 2, 3. Transceiver Module 4. Hand-Held Radio Chassis

Figure 1-2. Radio Receiver-Transmitter Set RT-1696/U(C) or RT-1695/TRC-199

1-1.2.3 Audio Accessories.

The operator has the option of several handsets/headsets. Because the receiver-transmitter does not have an internal speaker or microphone, the palm handset, or one of the optional audio accessories, must be used with the receiver-transmitter. The ear microphone is the only audio accessory that disables the alarm during transmission. Cryptographic alarm is audible with palm handset and H-250/U during transmission. See Table 4-2 for additional information on audible tones and alarms.

1-1.2.3.1 Palm Handset.

(See Figure 1-3.) A palm handset is the standard handset for the receiver-transmitter. It consists of a loudspeaker, microphone, and push-to-talk (PTT) switch mounted in a compact enclosure.

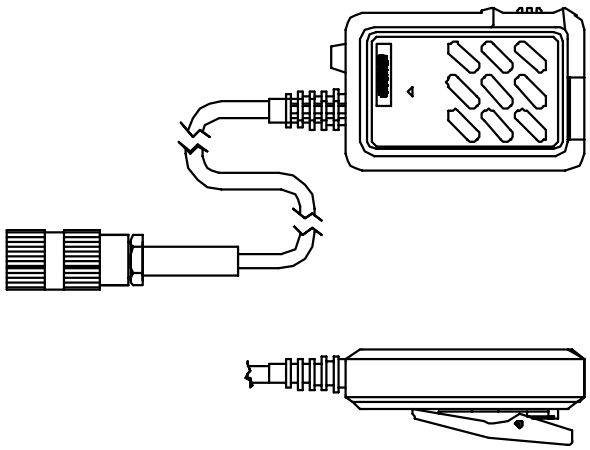


Figure 1-3. Palm Handset

1-1.2.3.2 Handset H-250/U

(See Figure 1-4.) The H-250/U Handset is the recommended Government inventory handset. It is a lightweight and rugged speaker/microphone.

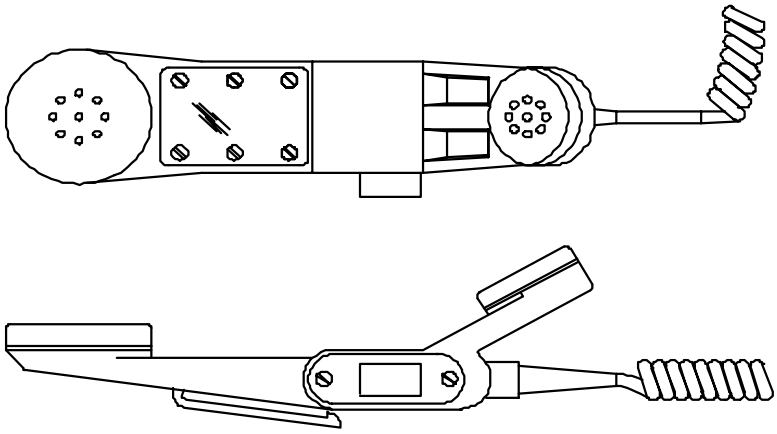


Figure 1-4. Handset H-250/U

1-1.2.3.3 Headset, Ear Microphone.

(See Figure 1-5.) The ear microphone is an optional audio accessory that allows the operator to discreetly monitor/send receiver-transmitter transmissions with a small microphone/speaker that fits over the operator's ear (similar to a hearing aid). The microphone/speaker has separate earpiece coverings that are available in different sizes to accommodate different users. The small size of the ear microphone allows it to be worn with all types of battlefield helmets. The ear microphone has both a belt-mounted PTT switch and a ring-mounted PTT switch. Either one must be pressed to begin transmission. The ear microphone is the only audio accessory that disables the alarm audio and warning tones during transmission.

NOTE
COMMUNICATIONS SECURITY

When using the ear microphone accessory, the operator should be aware that alarm audio and warning tones will not be heard during transmission. Cryptographic alarm will be heard after release of the PTT switch. Clear mode operation is indicated by a flashing amber LED on the receiver-transmitter and audible beeps (in receive only).

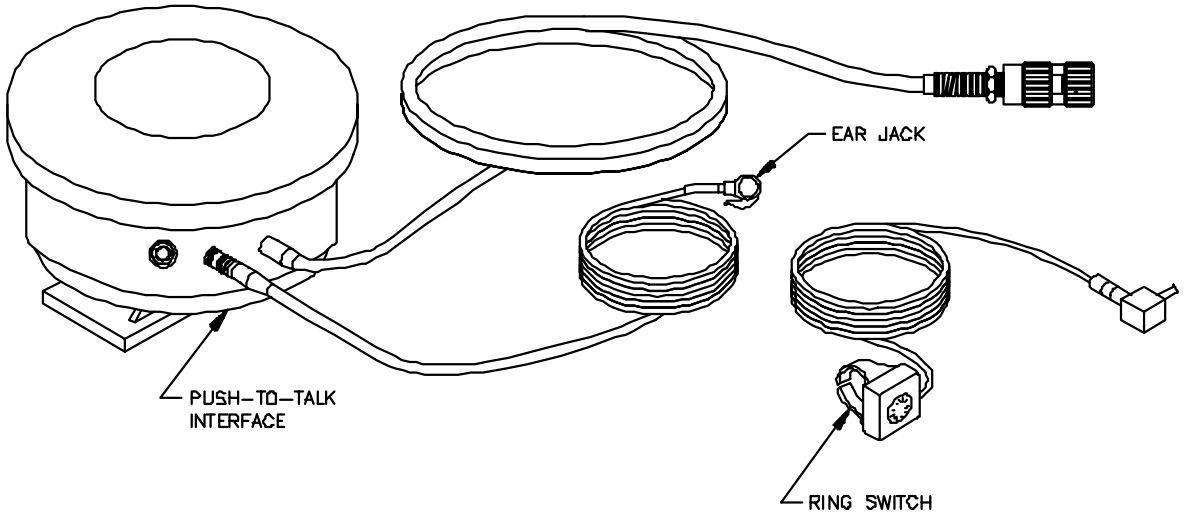


Figure 1-5. Headset, Ear Microphone

1-1.2.4 Camouflage Carrying Bag.

The receiver-transmitter is equipped with a camouflage carrying bag for use in the field. It provides for storage of the receiver-transmitter, a spare battery, handset, and a spare antenna. The carrying bag allows access to the receiver-transmitter controls and easy removal of the receiver-transmitter. It has a removable strap for shoulder carrying, separate securely closable pockets for storage of spare battery (under the receiver-transmitter), a spare antenna, and a handset.

1-1.2.5 Duty Carrying Bag.

A duty carrying bag is available as an accessory. This bag provides a means to carry the receiver-transmitter. It is not used to carry any additional items such as a spare battery or handset.

1-1.2.6 Lanyard.

The lanyard is a spiral, kevlar cord that can be attached to the operator's belt and the receiver-transmitter to prevent loss or damage of the receiver-transmitter through dropping.

1-1.2.7 Programmer Unit, Frequency, Radio MX-11531/U (Frequency Fill Device).

The frequency fill device provides a means of viewing and changing the hand-held radio programmable parameters, such as output power, channel frequencies, and squelch levels. A complete description, as well as operation and maintenance procedures, is contained in Appendix A of this TO.

1-1.2.8 Battery Reconditioner/Analyzer.

(see Figure 1-6). A Nickel Cadmium (NiCad) battery reconditioner is available as an accessory to the hand-held radio. The reconditioner can be used to "prime" (initially charge), "auto" (deep discharge and recharge), or fast charge up to four NiCad batteries at once. Appendix B contains a full description of battery reconditioner operation and maintenance, as well as information on the use and care of NiCd batteries.

1-1.2.9 Batteries and Battery Chargers.

(See Figure 1-7). The receiver-transmitter is battery powered. It is furnished with two rechargeable Nickel Cadmium (NiCad) batteries that will provide up to 12 hours of operation each. A non-rechargeable lithium battery, which provides up to 24 hours of operation, is available as optional equipment (refer to paragraphs 5-2.3 and 5-2.4 for additional information). Multiple and single station battery chargers (one or the other) are available as accessories for charging the NiCad batteries. The multiple station battery charger has the capability to charge up to six batteries simultaneously. Appendix B contains a full description of battery charger operation and maintenance.

Both chargers monitor battery temperature. If the battery temperature is between 0° Celsius (C) (32° Fahrenheit (F)) and 50°C (122°F), the charger will charge the NiCd battery in a fast charge mode. A discharged battery can be fully charged in fast charge mode in approximately three hours. If the battery temperature is below 0°C, the battery will be charged in trickle mode until it reaches charging temperature, at which point it will be placed on fast charge. If the battery is above 50°C, charging will not occur until the battery temperature decreases below 50°C. Other than the slightly different LEDs, the only difference between the multiple station battery charger and the single station battery charger is the number of batteries that can be charged at one time.

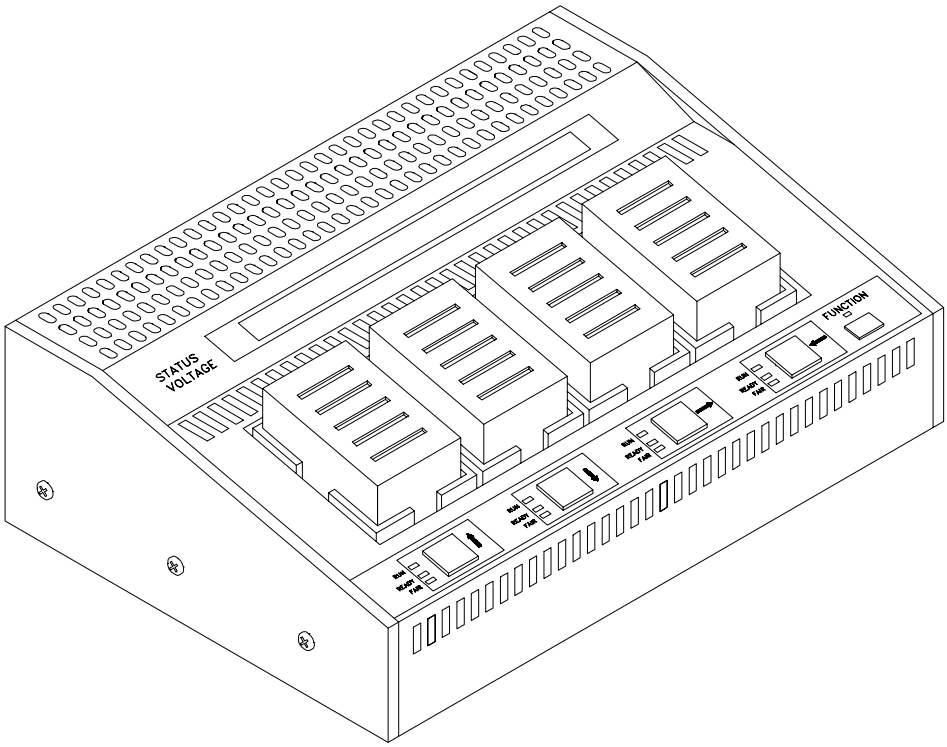


Figure 1-6. Battery Analyzer/Reconditioner

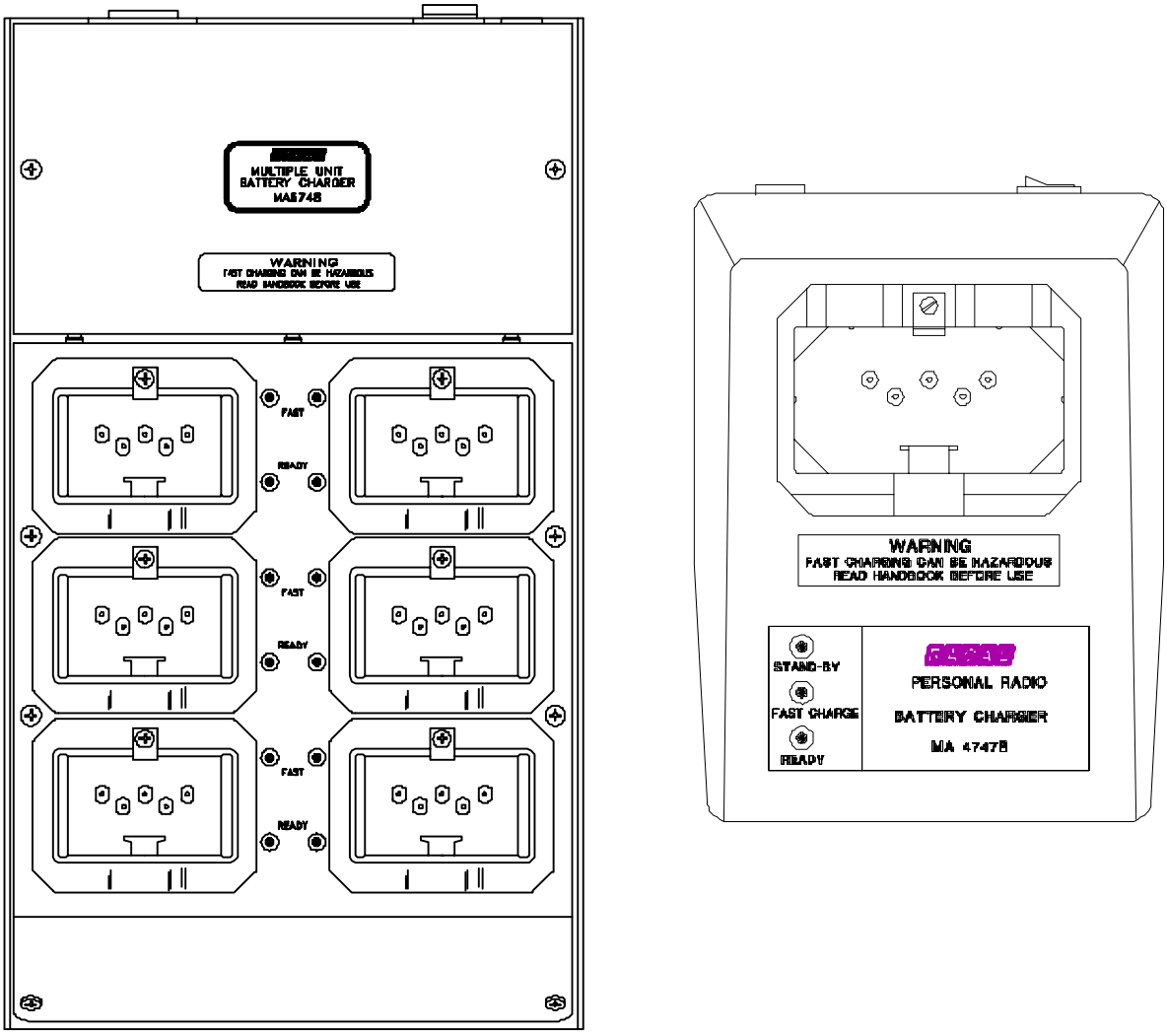


Figure 1-7. Multiple and Single Battery Chargers

1-2 LEADING PARTICULARS.

Leading particulars for the receiver-transmitter are given in Table 1-2.

Table 1-2. Leading Particulars

Characteristic	Parameter
Equipment dimensions and weight:	
Length	9.1 inches (in.) (23.11 centimeters (cm))
Width	3.0 in. (7.62 cm)
Height	1.8 in. (4.57 cm)
Volume	49.14 cubic in. (804.77 cubic cm)
Weight	3.3 lbs. (1.5 kilograms (kg))
Environmental requirements:	
Temperature:	
Operating	-30°C (-22°F) to +49°C (120°F)
Storage	-51°C (-60°F) to +68°C (155°F)
Immersion Proof	Immersion proof to a depth of two (2) meters in fresh water.
Electrical power requirements	10 Volts (V) direct current (DC) Rechargeable NiCad or Non-Rechargeable Lithium Battery

1-3 CAPABILITIES AND LIMITATIONS.

Capabilities and limitations of the receiver-transmitter are given in Table 1-3.

Table 1-3. Capabilities and Limitations

Characteristic	Parameter
Frequency Range:	
30-88 MHz	25.0 kilohertz (kHz) bandwidth
136-174 MHz	12.5 kHz and 25.0 kHz bandwidth
403-470 MHz	12.5 kHz and 25.0 kHz bandwidth
Transmitter Output	0.5 and 2 watts programmable
Security	TEMPEST compliant INDICTOR chip

Characteristic	Parameter
Channels (receive and transmit frequencies)	14 programmable channels
Adjacent Channel Selectivity	50 dB over 30-88 MHz, 25 kHz Bandwidth 52 dB over 136-174 MHz, 12.5 kHz Bandwidth 60 dB over 136-174 MHz, 25 kHz Bandwidth 40 dB over 403-470 MHz, 12.5 kHz Bandwidth 48 dB over 403-470 MHz, 25 kHz Bandwidth
Sensitivity	-116 dBm or 0.35mV for 12 decibels (dB) ratio of signal + noise +distortion/noise + distortion (SINAD)
Spurious Response and Image Rejection	65 dB over all three bands
Intermodulation Spurious Response Attenuation	60 dB over 30-88 MHz 60 dB over 136-174 MHz 60 dB over 403-470 MHz 25 kHz bandwidth
Channelization	25 kHz bandwidth channel spacing on all frequency bands 12.5 kHz bandwidth channel spacing on 136-174 MHz (clear mode only) 12.5 kHz channel spacing on 403-470 MHz bands (clear mode only) 12.5 kHz tuning steps

1-4 EQUIPMENT SUPPLIED.

Equipment supplied with Radio Set AN/PRC-139(C) is listed in Table 1-4.

Table 1-4. Equipment Supplied

Official Nomenclature or Common Name	Part Number	Quantity
Receiver-Transmitter Set, Radio RT-1696/U(C), including: 30-88 MHz Transceiver module 136-174 MHz Transceiver module 403-470 MHz Transceiver module	SS-4100807-502 SS-4100820-501 SS-4100821-501 SS-4100822-501	1 1 1 1
Antenna, Whip Helical, 30-88 MHz	CAF25422	1
Antenna, 1 Meter Whip, 30-88 MHz	SS-2100334-501	1
Antenna, Whip Helical, 136-174 MHz	SS-1600293-1	1
Antenna, Whip Helical, 403-470 MHz	CAF26165	1
Lanyard	SS-1600240-1	1
Handset, Palm	SS-1600289-1	1
Carrying Bag, Camouflage	SS-1600245-1	1
NiCad Battery	SS-1600350-1	2

1-5 OTHER EQUIPMENT.

Table 1-5 lists accessories that are used with the hand-held radio but not supplied. Table 1-6 lists optional equipment that may be used with the hand-held radio, but that are not required for normal operation. This equipment must be ordered separately from the Radio Set AN/PRC-139(C).

Table 1-5. Equipment Required But Not Supplied

Description	Part Number
Battery Charger, Single Station, or	SS-4100846-501
Battery Charger, Multiple Station	SS-4100885-501
Programmer Unit, Frequency, Radio	NX-11531/U
COMSEC Fill Cable	SS-3500280-501
Frequency Fill Device Cable	SS-4100797-501

Table 1-6. Optional Equipment

Description	Part Number
Cloning Cable	SS-3500272-501
Duty bag	SS-5005AN (K8916) *
Battery, Non-Rechargeable, Lithium	SS-1600351-1
Handset	H-250/U
Headset, Ear Microphone	ERS-601R-RACAL (05H60) *
Battery Reconditioner	R2000

NOTE

- Part not listed in IPB; CAGE code not provided elsewhere in TO.

1-6 SPECIAL TOOLS AND TEST EQUIPMENT.

There are no special tools or test equipment required for organizational level maintenance of the Radio Set AN/PRC139(C).

1-7 RELATED TECHNICAL MANUALS.

Table 1-7 lists related technical manuals.

Table 1-7. Related Technical Manuals

Publication Number	Publication Title
31R2-2TRC199-1	Operation and Maintenance Instructions with Illustrated Parts Breakdown (Organizational Level) for Radio Set AN/TRC-199
31R2-2GRC238-1	Operation and Maintenance Instructions with Illustrated Parts Breakdown (Organizational Level) for Radio Set AN/GRC-238
31R2-4-1085-1	Operation and Maintenance Instructions with Illustrated Parts Breakdown (Organizational Level) for Adapter Group, Radio OF-228/U
31R2-2PRC139-06	Work Unit Code Manual
KAM-330	Operating Instructions for KOI-18 and KYK-13 COMSEC Fill Devices
ON477340	AN/CYZ-10 Data Transfer Device Users' Manual

CHAPTER 2. INSTALLATION

2-1 INTRODUCTION.

This section is divided into two sections. Section I, Installation Logistics, provides information for site preparation, unloading, unpacking and inspections, housing, receiving data, material handling, cabling, and buildings and other structures. Section II, Installation Procedures, lists tools and equipment required for field installation and describes the installation sequence.

Section I. INSTALLATION LOGISTICS

NOTE
CONTROLLED CRYPTOGRAPHIC ITEM

The receiver-transmitter part of the hand-held radio is a controlled cryptographic item (CCI). Consult your COMSEC manager for security procedures applicable to the control, use, and storage of this hand-held radio.

2-2 SITE PREPARATION.

Not Applicable.

2-3 UNPACKING AND INSPECTION.

CAUTION

Exercise care when removing from packing material in order to prevent damage to the unit.

To unpack the hand-held radio, remove the unit and any equipment from the carton and store the packing and carton for reuse/shipment. Packing instructions are given in Chapter 3. Inspect contents for completeness, integrity, and damage. Contents shall be in accordance with the packing slip and the list of supplied equipment in Table 1-4.

Refer to Figure 2-1 as a guide in the performance of the following unpacking and inspection procedures:

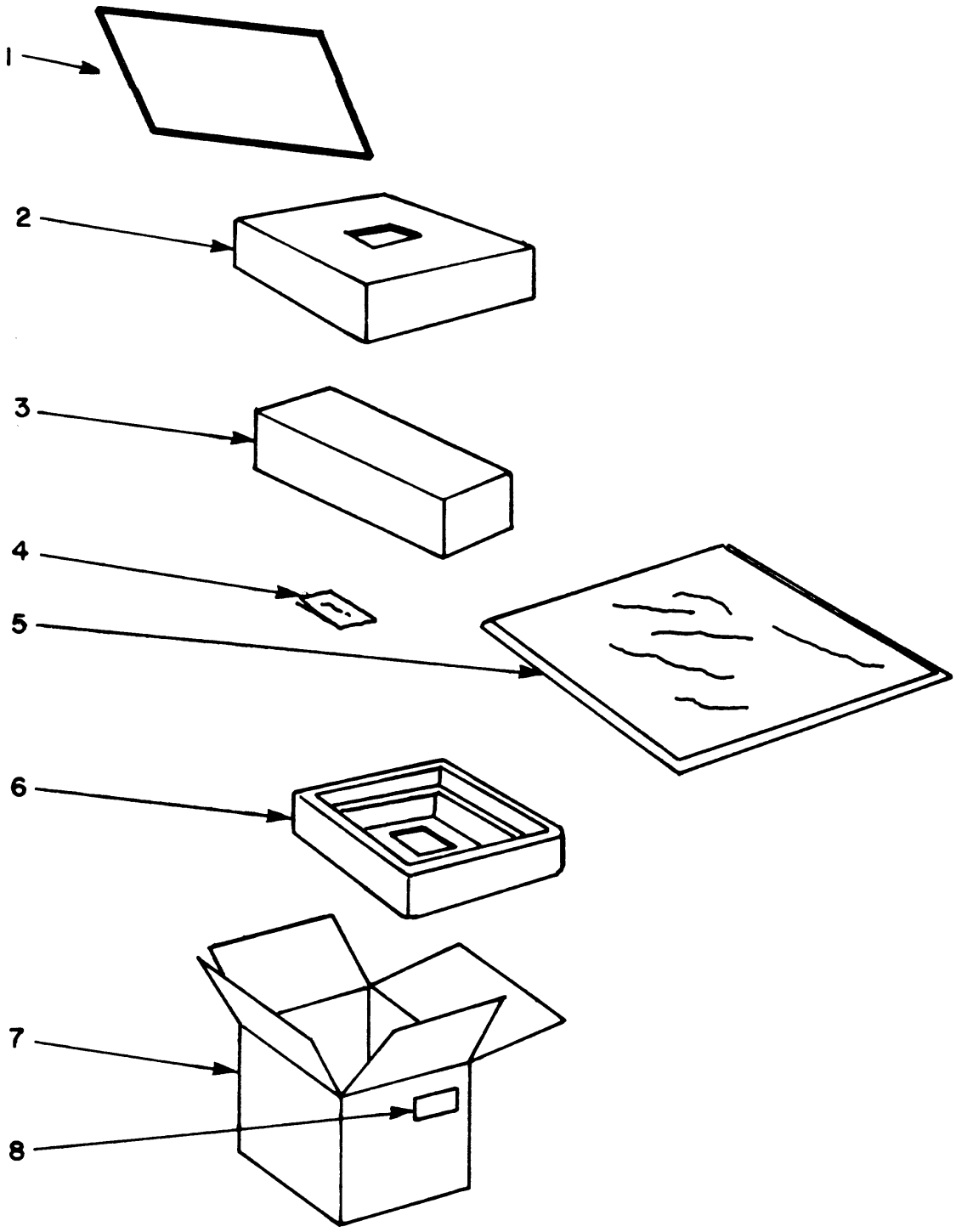
a. Open top of the fiberboard box (7, Figure 2-1) and remove the operating instructions (1) and polystyrene top (2) from container.

b. Remove barrier bag (5) from the box.

c. Remove packing slip (8) from the plastic envelope on the fiberboard box and check to ensure that all items listed on the packing slip were received. Each component of the hand-held radio is placed in an individual cutout in the package foam insert to allow ready verification of system completeness.

d. Store all packing materials (except desiccant) in the fiberboard box and store fiberboard box for re-use. Discard the original desiccant. New desiccant material should always be used for re-packing.

e. Inspect top and bottom, both sides, and front and rear panels of equipment for dents, scratches or any visually identifiable structural damage.



Legend for Figure 2-1:

1. Operating instructions
2. Polystyrene top
3. Receiver-transmitter
4. Desiccant bag
5. Barrier bag
6. Polystyrene bottom
7. Fiberboard box
8. Packing slip

Figure 2-1. Packaging Diagram for the Radio (Typical)

f. Inspect controls and indicators on top panel for missing, broken or cracked knobs or levers. Note any discrepancies on DD 1348-1.

2-4 HOUSING.

If necessary to store the hand-held radio, proceed as follows:

NOTE
COMMUNICATIONS SECURITY

Ensure that the receiver-transmitter is zeroized (operating mode switch (5, Figure 4-1) turned to Z position) before placing the receiver-transmitter in storage. This will ensure that the keys installed in the receiver-transmitter are not compromised.

a. Clean the hand-held radio before placing in storage (see paragraph 6-3.3.2).

b. Remove batteries from the receiver-transmitter.

NOTE

The temperature of the storage area must be within the range -51°C (-60°F) to +68°C (+155°F).

2-5 RECEIVING DATA.

Table 2-1 identifies the contents and particulars of the shipping container.

Table 2-1. Items Required to Complete Installation

Qty	Item	Dimensions (In.)			Weight (lb.)
		W	H	D	
1	Radio Set AN/PRC-139(C)	23.5	13.5	23.5	22

2-6 MATERIAL HANDLING.

No material handling equipment is required in the installation of the hand-held radio.

2-7 BUILDINGS AND OTHER SUPPORTING STRUCTURES.

Not applicable.

Section II. INSTALLATION PROCEDURES

2-8 TOOLS AND EQUIPMENT REQUIRED FOR FIELD INSTALLATION.

No tools or equipment are required for field installation of the hand-held radio.

2-9 INSTALLATION SEQUENCE.

Install the hand-held radio as follows:

NOTE

Prior to installing the battery on the receiver-transmitter, ensure that the power/volume switch (3, Figure 4-1) is in the OFF position for optimum service life. New NiCad batteries should be prepared for initial use in accordance with Appendix B.

a. Connect the fully charged battery to the hand-held radio. (See Figure 2-2.)

b. Connect an audio accessory, such as the supplied palm handset, to the audio accessory connector (2, Figure 4-3) on top of receiver-transmitter. Due to the tightness of the O-ring seal in the audio connector, it is recommended that the user first apply a non-conducting silicon lubricant, such as Dow-Corning 738 to the O-ring before connecting it to the receiver-transmitter.

NOTE

The operating band of the hand-held radio is determined by the transceiver module installed. When the transceiver module is first installed or changed, the receiver-transmitter must be fitted with the proper antenna as identified below:

Transceiver Module	Antenna
30-88 MHz (SS-4100820-501)	30-88 MHz (CAF25422 or SS-2100334-501)
136-174 MHz (SS-4100821-501)	136-174 MHz (SS-1600293-1)
403-470 MHz (SS-4100822-501)	403-470 MHz (CAF26165)

c. Connect the proper antenna to the receiver-transmitter by aligning the antenna connector (3, Figure 4-3) on top of receiver-transmitter. Turn antenna clockwise to thread it into position.

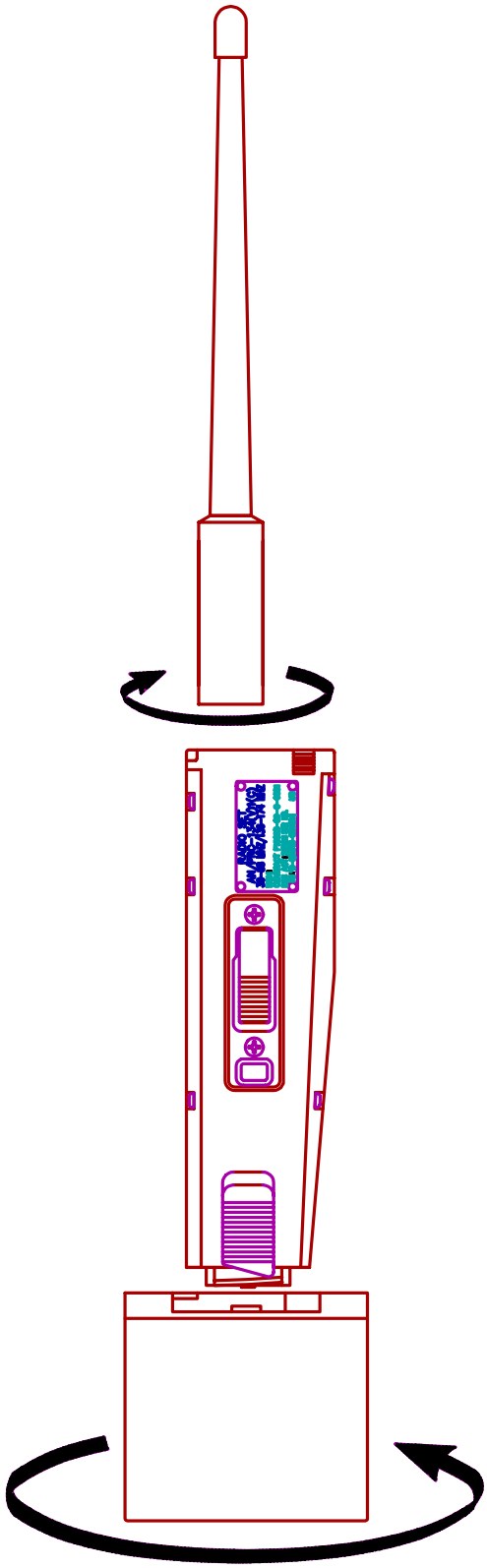


Figure 2-2. Receiver-Transmitter Battery and Antenna Installation

CHAPTER 3. PREPARATION FOR USE AND RESHIPMENT

3-1 INTRODUCTION.

This chapter is divided into two sections. Section I, Preparation For Use, provides post-installation operational checks that must be performed prior to operating the hand-held radio. Section II, Preparation For Reshipment, contains procedures for reshipment of the unit.

Section I. PREPARATION FOR USE

3-2 INSPECTION.

If the unit has not been checked as part of the installation process, or if the equipment has been in a non-operating condition, check that all connections are tight and no damage is visible on the exterior of the hand-held radio.

3-3 POST-INSTALLATION CHECKOUT.

3-3.1 Alignment and Adjustment.

The receiver-transmitter is aligned and adjusted for normal operation at the factory/depot. No other alignment or adjustment is necessary or authorized.

3-3.2 Post-Installation Checkout Procedures.

After completion of installation, perform the operational checkout included in paragraph 6-2.

Section II. PREPARATION FOR RESHIPMENT

3-4 PREPARING UNIT FOR RESHIPMENT.

Prepare the hand-held radio for reshipment as follows:

a. Ensure that all COMSEC keys have been zeroized. Refer to paragraph 4-12 for zeroize procedures.

b. Place the power/volume switch (3, Figure 4-1) in the OFF position.

c. Verify that the hand-held radio is off by pressing the PTT switch (3, Figure 4-2) and confirming that the transmit LED (1, Figure 4-1) is not illuminated.

d. Disconnect the audio accessory, antenna, and battery prior to reshipment.

3-5 PACKING.

Pack the hand-held radio in the recommended packages as described in Chapter 2. Use original packing materials if available.

3-6 HANDLING AND STORAGE.

Place electronic assemblies in individual containers. This will prevent damage during handling and storage. If a common container is used, use suitable barrier material between electronic assemblies. Sufficient packing must be used to prevent shifting of electronic assemblies within the container. Package the equipment in accordance with MIL-STD-2073-1A/2B. Marking for reshipment and storage shall be in accordance with MIL-STD-129J.

CAUTION

Never apply pressure sensitive tape directly to connectors. This could damage connector pins.

3-6.1 Protective Measure for Electrical Connectors.

Protect all unmated connectors that are exposed to physical or environmental damage by covering with supplied protective caps.

3-6.2 Preparation for Shipment and Storage.

Before preparing the equipment for shipment or storage, ensure that the COMSEC keys on the receiver-transmitter have been zeroized. Refer to paragraph 4-12 for zeroize procedure. Also ensure that battery and other accessories have been removed.

CAUTION

Package all ESD sensitive assemblies in ESD bags before shipping or storing.

NOTE
CONTROLLED CRYPTOGRAPHIC ITEM

The receiver-transmitter is a Controlled Cryptographic Item (CCI). Consult your COMSEC manager for security procedures applicable to the control, use, and storage of this receiver-transmitter.

For shipment to another facility or storage, package the unit as shown in Figure 2-1. Regardless of the electronic assembly design, fit all protruding parts with packing spacers, wrap the complete assembly with plastic or place in a plastic air-lock bag. Wrap with a protective cellulose, foam, or similar material. Wrap assemblies that contain electrostatic discharge sensitive (ESDS) parts in static protective materials.

3-6.3 Handling.

Following are general handling instructions which should be followed when handling the equipment.

CAUTION

Rough handling may cause damage to electronic assemblies.

CAUTION

Electronic assemblies containing solid-state devices are susceptible to damage from static electrical discharges. Place items in ESD bags. Wear protective clothing and grounded wrist straps.

CAUTION

Forcing any misaligned electronic assembly into position may result in bent or broken pins.

Be very careful when removing or inserting an assembly into the equipment. If it is a plug-in circuit card assembly (CCA), be sure the guide pins are properly aligned before pressing the assembly in place. If the CCA tilts while being inserted, do not continue to press into position; straighten it, then apply even pressure to avoid tilting.

CAUTION

When replacing an electronic assembly, be careful that the tool employed does not inadvertently press against leads, pins, or other parts that are easily bent.

CAUTION

When handling an assembly that has been removed from its chassis, be careful not to press against the leads and pins. When removing an assembly, be sure to pull it straight out from the equipment. Do not cock, twist, pry, or carelessly jerk an electronic assembly to remove it from the mounting or connector.

CAUTION

ELECTROSTATIC DISCHARGE

The hand-held radio contains components that are susceptible to damage by static electrical charges. Disassembly of the hand-held radio should only be done at a properly grounded work station.

CHAPTER 4. OPERATION

Section I. CONTROLS AND INDICATORS

4-1 INTRODUCTION.

This section describes and illustrates controls, indicators, and connectors of the hand-held radio.

4-2 CONTROLS AND INDICATORS.

The following paragraphs cover all operational controls and indicators of the hand-held radio.

4-2.1 Top Panel Controls and Indicators.

Controls and indicators on the receiver-transmitter top panel are illustrated in Figure 4-1 and described in Table 4-1.

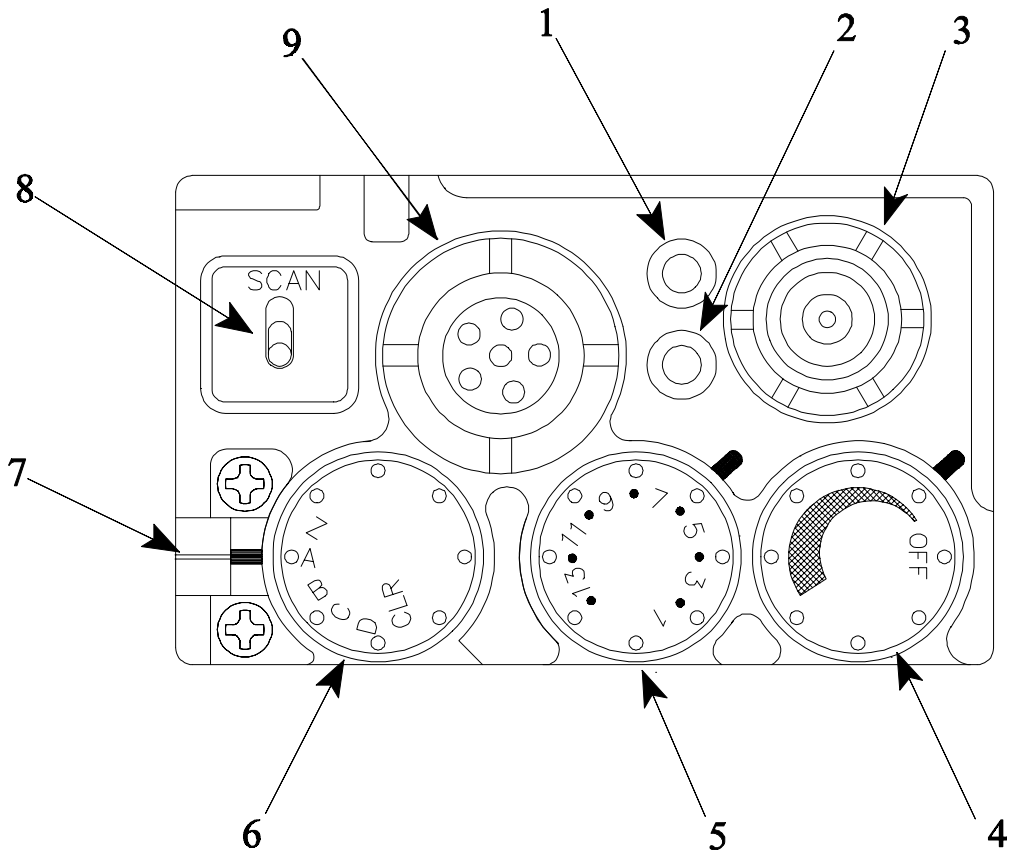


Figure 4-1. Top Panel Controls and Indicators

Table 4-1. Description of Top Panel Controls and Indicators

Fig & Index Number	Control/Indicator	Function
4-1-1	Transmit LED (green LED with narrow viewing angle)	Provides the following indications: Major Error Alarm - Flashes 60 milliseconds (ms) on and 60 ms off when radio malfunction alarm is active. (Refer to Table 4-2 for description of audible signals.) Low Battery Warning - Flashes 500 ms on and 500 ms off while PTT is pressed. Cloning Enable - Flashes 100 ms on and 100 ms off during cloning operations if properly connected to the cloning cable. (Refer to paragraph 4-11 for more detail.) Cloning Success - Continuously illuminated if cloning operations are successfully accomplished. (Refer to paragraph 4-11 for more detail.) Scan On - Flashes 30 ms on and 500 ms off in receive mode when SCAN enable/disable switch is in enable position. (Refer to paragraph 4-8 for more detail.)
4-1-2	Transmit/Receive in Clear LED (amber)	Flashes 30 ms on and 1000 ms off to indicate receiver-transmitter is operating in clear (unencrypted) mode. The function of this LED may not be disabled.
4-1-3	Power/Volume Switch	Provides on/off control of power and provides six-stepped volume positions. The first two positions select whisper mode. (Refer to paragraph 4-7.) The remaining positions progressively increase the audio volume.
4-1-4	Channel Select Switch	Selects a pre-programmed, channel 1 through 14. Channel 1 is reserved for priority use in conjunction with scan function when the scan mode is enabled.

Table 4-1. Description of Top Panel Controls and Indicators - CONT

Fig & Index Number	Control/Indicator	Function
4-1-5	Operating Mode Switch	Selects receiver-transmitter operating mode as follows: CLR - Selects clear speech mode. A, B, C, and D - Selects secure mode with key variables (codes A, B, C, and D). Key variable A is used for COMSEC key encryption key (KEK) storage and is used to receive over-the-air key updates. (Over-the-air updates are performed by the network controller, and do not require any operator action.) Key variables B, C, and D are used for COMSEC traffic encryption key (TEK). TEKs are used for normal encrypted voice point-to-point communications. Z - Selects key zeroize key function. Clear and zeroize are both protected by a mechanical interlock.
4-1-6	Mechanical Interlock	Prevents operator from inadvertently turning the operating mode switch to either Z (zeroize) or CLR (clear) modes. In order to select either Z or CLR modes, the operator must press the mechanical interlock while turning the operating mode switch to desired position.
4-1-7	SCAN Enable/Disable Switch (toggle switch)	SCAN (up) position enables periodic scanning of the priority channel (channel 1). With SCAN enabled, the receiver checks channel 1 every second for any traffic. The receiver remains in SCAN mode for 40 ms if no carrier frequency is detected. If a carrier is detected, it remains in SCAN for 200 ms to detect errors. Down position disables scanning.

4-2.2 Audible Warning Tones and Alarms.

Audible warning tones, alarms, and indicators are described in Table 4-2.

Table 4-2. Description of Audible Warning Tones and Alarms

Control/Indicator	Function
Radio Malfunction/Error	Two-tone siren 1 kHz (500 milliseconds (ms))/2 kHz (500 ms) Level -20 dB with respect to signal
Activated By:	a. Synthesizer OOL for more than 30 ms. b. Transmit time limiter has cut-off transmission. c. Secure mode selected but no crypto fitted. d. Secure selected and 12.5 kHz bandwidth. e. Bandwidth secure mode selected in wideband (WB).
Low Supply	Beeps 2 kHz (25 ms)/OFF (475 ms) Level -20 dB with respect to signal
Clear Speech Mode	Slow beeps 2 kHz (30 ms)/OFF (1970 ms) (-16 dB with receiver-transmitter in transmit)
Transmit Time Limiter Impending:	Rapid pips 2 kHz (65 ms)/OFF (200 ms) Level -20 dB with respect to signal
Activated Before Limiter Operates:	Commences 5 seconds before transmit cut-off
Crypto Alarm	Continuous tone of 1/16 of the data rate (1 kHz at 16 kBs and 750 Hz at 12 kBs)
For Crypto Specified Failure Modes	Carrier modulation is inhibited
Scan Mode Active (traffic detected on Channel 1)	Hailing tone: 1 kHz 320 ms ON/320 ms OFF Level -20 dB with respect to signal
To Indicate Traffic Detected on Scan Channel	Activated for 5 seconds after detection

4-2.3 Side Panel Battery Latch and Switches.

The battery latch and operator switches on the receiver-transmitter side panel are illustrated in Figure 4-2 and described in Table 4-3.

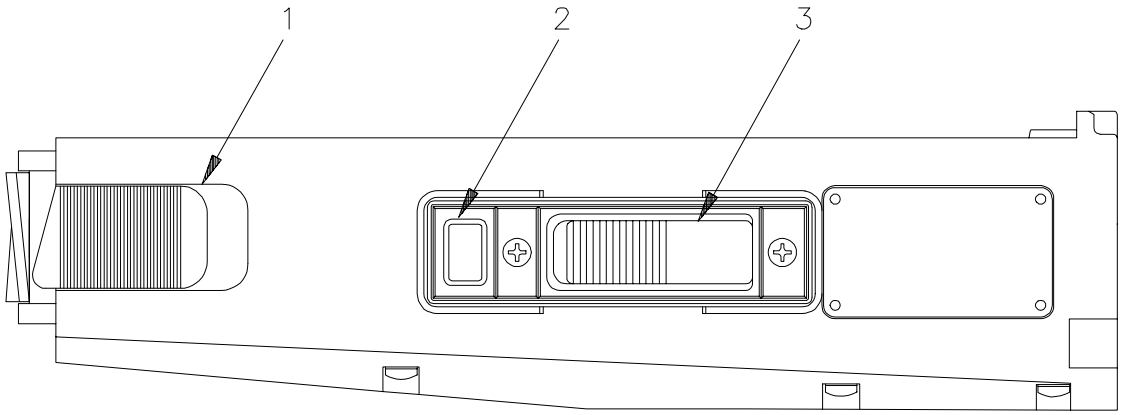


Figure 4-2. Side Panel Battery Latch and Switches

Table 4-3. Description of Side Panel Battery Latch and Switches

Fig & Index Number	Latch/Switch	Function
4-2-1	Battery Latch (side mounted spring-loaded latch)	Locks battery in place. To remove the battery, slide the latch up toward the PTT button and twist the battery counter-clockwise.
4-2-2	Squelch Override Switch (side mounted, push-on, push-off button)	When pressed once, squelch is opened and a continuous rushing noise is heard. When pressed again, squelch is closed and the continuous rushing noise stops.
4-2-3	PTT switch (side mounted spring-loaded, push-on button)	Used in cloning and loading keys. (Can also be used to activate attached audio accessories)

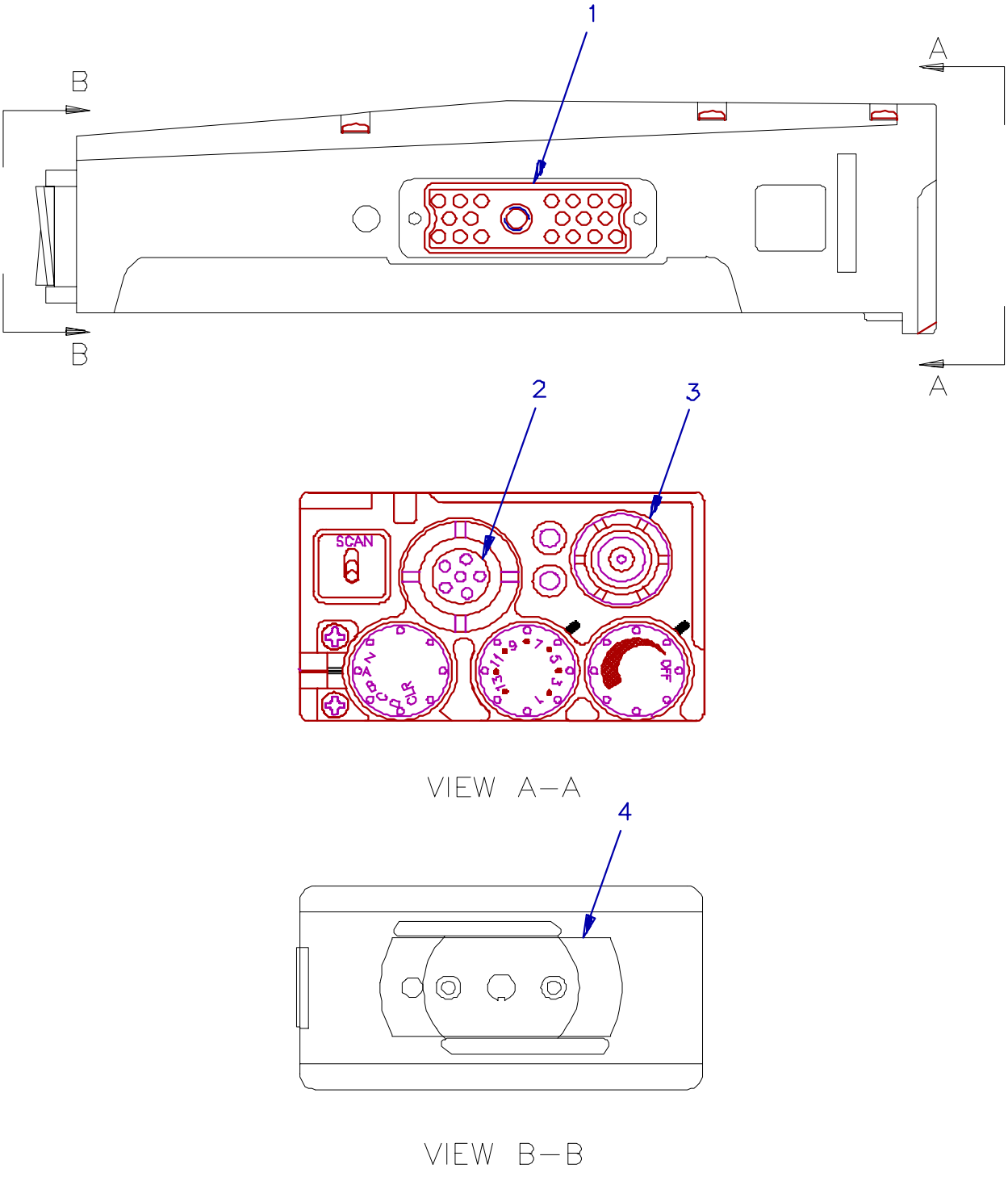


Figure 4-3. Connectors

4-2.4 Connectors.

Connectors on the receiver-transmitter top panel are illustrated in Figure 4-3 and described in Table 4-4.

Table 4-4. Connectors

Fig & Index Number	Connector	Function
4-3-1	Side Connector	Provides contacts for electrical interface to the receiver-transmitter while it is inserted into the base station, vehicle adapter, or tactical repeater. Also used during frequency cloning and key filling. (Refer to paragraphs 4-5.2 and 4-11.)
4-3-2	Audio Accessory Connector	Connects an audio accessory to the receiver-transmitter. To connect an accessory to the receiver-transmitter, insert the plug from the accessory into the connector with the flat side of the plug facing the transmit side of the receiver-transmitter. While pressing firmly, turn the plug clockwise one-quarter turn to lock into place. To remove, press down firmly on the plug and turn counterclockwise one-quarter turn.
4-3-3	Antenna Connector	Connects antenna to the receiver-transmitter. To connect an antenna, thread the antenna plug into the connector. Turn clockwise until tight to lock into place. To remove, turn counterclockwise.
4-3-4	Battery Connector	Connects battery to the receiver-transmitter.

WARNING

Section II. OPERATING INSTRUCTIONS

Do not change battery within 10 feet of open fuel/fuel vents or operate the radio within 10 feet of aircraft fuel vent outlets, open port refueling receptacles, or fuel spills.

4-3 INITIAL POWER-UP PROCEDURE.

Perform the following procedure to power up the receiver-transmitter:

a. Ensure that either a palm handset (SS-1600289-1), a headset with ear microphone (SS-1600312-1), or an H-250/U handset is connected to the audio accessory connector (2, Figure 4-3).

b. Ensure that the proper antenna (i.e. same frequency band as installed transceiver module) is connected to the antenna connector (3, Figure 4-3). See paragraph 2-9g.

c. Ensure that either a charged NiCad battery (SS-4100818-501) or a non-rechargeable Lithium battery (SS-4100796-501) is connected to the receiver-transmitter battery connector. (See paragraph 2-9f.)

d. Turn the power/volume switch (3, Figure 4-1) to mid-range position. Ensure that no warning tones are heard. (Refer to Table 4-2.)

e. Using the channel select switch (4, Figure 4-1), select the assigned transmit and/or receive channel.

f. Press the mechanical interlock (6, Figure 4-1), and select clear mode (CLR) operation by turning the operating mode switch (5, Figure 4-1) to the CLR position.

g. Using the operating mode switch (5, Figure 4-1), select a secure mode (B, C, or D). Press the PTT until no alarms are heard.

h. Program the hand-held radio as described in paragraph 4-4.

i. Load COMSEC keys as described in paragraph 4-5.

j. Depress the PTT switch (3, Figure 4-2) to load the selected COMSEC key.

k. The receiver-transmitter is now in the standby mode and ready for normal operation.

4-4 HAND-HELD RADIO PROGRAMMING.

4-4.1 Programming Requirements Matrix.

The frequency fill device is used to program either the RT-1695/TRC199 or RT-1696/U(C). Table 4-5 provides a programming requirements matrix for the frequency fill device. Detailed programming procedures are given in Appendix A.

Table 4-5. Frequency Fill Device Programming Requirements Matrix

Programmable Function		Parameter Classification			Zeroized Default Values
Function	Parameters	Global	Channel	Execute	
• Carrier Squelch Level	6, 8, 10, 12, 14, 16 dB	X			8 dB
• TX Timeout	30, 60, 90, 120 seconds, or INF (Infinite)	X			INF
• Clone Control	Master, Slave, Disabled, No Change	X			Disabled
• Zeroize Receiver-Transmitter	Initiate erasure of all receiver-transmitter programmed data.			X	--
• RX Frequency	30-88 MHz (inclusive) in 12.5 kHz steps Tactical-Band Receiver-Transmitter 136-174 MHz (inclusive) in 12.5 kHz steps High-Band Receiver-Transmitter 403-470 MHz (inclusive) in 12.5 kHz steps UHF-Band Receiver-Transmitter		X		0 MHz
• TX Frequency	(same as RX Frequency above)		X		0 MHz
• RX CTCSS Tone	100.0, 103.5, 107.2, 110.9, 114.8, 118.8, 123.0, 127.3, 131.8, 136.5, 141.3, 146.2, 151.4, 156.7, 162.2, 167.9, NONE and 150.0 Hz (150.0 Hz - 30-88 MHz T-band Receiver-Transmitters only)		X		NONE
• TX CTCSS Tone	(same as RX CTCSS Tone above)		X		NONE
• RF Transmit Power	0.5, 2.0 Watts		X		2.0 W
• RX IF Bandwidth	12.5, 25.0 kHz for 136-174 MHz and 403-470 MHz band Receiver-Transmitters only. 12.5 kHz in clear transmission only.		X		25 kHz
• Secure Data Rate	12, 16 kbps		X		16 kbps

4-4.2 Programmable Features.

Table 4-6 defines programmable features of the receiver-transmitter.

Table 4-6. Programmable Features

Programmable Feature	Parameter Limits	Function and Purpose
Carrier Squelch Level	6, 8, 10, 12, 14, and 16 dB	This feature is used to determine the received signal strength that will "break squelch" (the radio recognizes that traffic is being received). The higher values (16, 14, etc.) should be used in high traffic density areas and where the desired traffic is being broadcast only over short ranges (one mile or less). The lower values (6, 8, etc.) should be used where there is limited radio traffic and the desired traffic is being broadcast at the limits of effective range.
Transmit (TX) Timeout	30, 60, 90, 120, seconds and INF (No limit)	This feature automatically ends transmission after a fixed period of time. The purpose is to prevent inadvertent or prolonged operation in transmit mode that can significantly shorten battery charge life.
Clone Control	Master, Slave, No Change, and Disabled	This feature determines the cloning capability of the hand-held radio. • Master: can clone other radios as master radios, which can in turn clone other radios as master radios in an indefinite chain; • Slave: can clone other radios as clone disabled radios; • No Change: can clone all programmable information into another radio without changing the initial cloning state of the target radio (i.e., does not transfer cloning data - master remains master, slave remains slave); • Disabled: cannot clone another radio.
Zeroize Receiver-Transmitter		This feature deletes all user-programmable information from the radio except COMSEC keys.
Receive (RX) Frequency	• 30-88 MHz (inclusive in 12.5 kHz steps • 136-174 MHz (inclusive) in 12.5 kHz steps • 403-470 MHz (inclusive) in 12.5 kHz steps	This feature is used to set the receive frequency for each of the 14 radio channels. The frequency for each channel must be programmed separately. Frequency tuning steps (minimum separation of two channels) are 12.5 kHz. The frequencies set shall be those allocated by the activity Frequency Allocation Manager.
TX Frequency	• 30-88 MHz (inclusive in 12.5 kHz steps • 136-174 MHz (inclusive) in 12.5 kHz steps • 403-470 MHz (inclusive) in 12.5 kHz steps	This feature is used to set the transmit frequency for each of the 14 radio channels. When a channel receive frequency is set, the transmit frequency for that channel is automatically set to the same frequency. However, the transmit frequency may be programmed separately to a different value. Frequency tuning steps (minimum separation of two channels) are 12.5 kHz. The frequencies set shall be those allocated by the activity Frequency Allocation Manager.

Table 4-6. Programmable Features - CONT

Programmable Feature	Parameter Limits	Function and Purpose
RX Continuous Tone Controlled Squelch System (CTCSS) Tone	100.0, 103.5, 107.2, 110.9, 114.8, 118.8, 123.0, 127.3, 131.8, 136.5, 141. 3, 146.2, 151.4, 156.7, 162.2, 167.9 Hz, and NONE 150.0 Hz for 30-88 MHz transceiver module only	This feature allows the radio to be programmed to receive only selected radio traffic, i.e., only traffic with the selected CTCSS tone. A different tone, or no tone, can be programmed for each channel.
TX CTCSS Tone	Same as RX CTCSS Tone	This feature allows the radio to be programmed to transmit a specific CTCSS tone, which will be received only by other radios programmed to receive traffic with that tone. The TX tone for a specific channel is automatically set when the RX tone for that channel is programmed. A different tone, or no tone, can be separately programmed for each channel.
Radio Frequency (RF) Transmit Power	0.5 or 2.0 watts	This feature allows the selection of two levels of transmit power. The lower level conserves battery life and limits transmission range. The higher level will increase the transmission range, but limits battery life.
RX Intermediate Frequency (IF) Bandwidth	12.5 or 25.0 kHz for 136-174 and 403-470 transceiver modules only	This feature determines the bandwidth of the RF radio signal. The bandwidth is normally set by the Frequency Allocation Manager. The radio must be set to 25 kHz IF bandwidth for secure operation and must be set to 12.5 kHz IF bandwidth for compatibility with 12.5 kHz commercial radios.
Secure Data Rate	12 or 16 kbps	This feature allows the selection of two different data rates for secure operation and determines the interoperability of the radio. 12 kbps shall be selected for FED-STD-1023 compatible operation (most commercial secure radios) and 16 kbps shall be selected for VINSON compatible operation.

NOTE

For interoperability with the AN/PRC-77, the RX CTCSS Tone must be set to NONE and the TX CTCSS Tone must be set to 150.0 Hz.

4-4.3 Loading Programming Information.

Load the receiver-transmitter through the side connector (1, Figure 4-3). Refer to the Receiver-Transmitter Programming instructions included in Appendix A.

4-5 LOADING COMSEC KEYS.

The following paragraphs describe the procedure for loading traffic encryption keys (TEKs) into the receiver-transmitter from either a KOI-18 or KYK-13 COMSEC fill device or an AN/CYZ-10 Data Transfer Device. Loading of a key is required to allow the receiver-transmitter to encrypt/decrypt data. Before loading a key, zeroize the receiver-transmitter as described in paragraph 4-12. Refer to TO KAM-330 for KYK-13 and KOI-18 operating instructions. In order to perform the following procedures, the radio set *must* have been powered on for a minimum of 30 seconds to ensure charging of the key retention capacitor. Traffic Encryption Keys (TEKs) for the KYK-13 are obtained from your COMSEC manager.

NOTE

Mode position A of the operating mode switch is used for receiving over-the-air rekey from the network controller only. Do not load TEKs into mode position A. The handheld radio can only receive over-the-air rekey. It *cannot* transmit over-the-air rekey.

NOTE

Mode position A, Key Encryption Key (KEK), is loaded in the same manner as positions B, C, and D. However, due to the use of this key it must be specifically requested from the COMSEC manager. This key will be loaded based on user need for over- the-air rekey *only*. Over-the-air rekey will work only when the receiving handheld radio has *both* a valid KEK and a valid TEK already loaded.

NOTE

After a new key is loaded, or when switching from one key to another, the new key must be *activated* before encrypted traffic can be sent or received. Keys are activated by momentarily pressing and releasing the PTT switch.

4-5.1 Loading Key From KOI-18 Into Hand-Held Radio.

Load key from the KOI-18 as follows:

a. Set the hand-held radio operating mode switch (5, Figure 4-1) to the position to be loaded (B, C, or D). If an alarm sounds, press and release the PTT switch (3, Figure 4-2) until the alarm ceases. The alarm cannot be heard unless an audio accessory, such as the palm handset, is used.

b. Connect the KOI-18 to the hand-held radio side connector (1, Figure 4-3) via the crypto fill cable (SS-3500280-501).

c. Insert leader of the tape containing key(s) into the KOI-18 IN slot in the direction shown on the back side of the KOI-18 IN slot cover. Ensure guide holes on tape are aligned with the dots on the KOI-18 cover. Push the tape through until enough is showing on the KOI-18 OUT slot to grab hold of.

CAUTION

Take care not to pull the multiple punched hole section of the tape through at this time.

d. Press and release the PTT switch on the hand-held radio.

e. Slowly pull the tape through the KOI-18 by grasping the tape available at the KOI-18 OUT slot.

CAUTION

Do not, under any circumstances, pull the tape backwards through the KOI-18.

f. To load additional keys, select the key position to be loaded on the hand-held radio mode switch and repeat steps c through e.

g. When all desired keys have been loaded, disconnect the KOI-18 from the hand-held radio.

h. Check the stored TEKs on the hand-held radio by attempting to communicate with another radio.

4-5.2 Loading Key From KYK-13 Into Receiver-Transmitter.

Load key from the KYK-13 into the receiver-transmitter as follows:

a. Set the hand-held radio operating mode switch (5, Figure 4-1) to the key position to be loaded (B, C, or D). The hand-held radio should sound an alarm. The alarm cannot be heard unless an audio accessory, such as the palm handset, is used.

b. Firmly press and release the PTT switch (3, Figure 4-2) and wait several seconds until the alarm is cleared. Repeat if necessary to clear the alarm.

c. Ensure that the KYK-13 mode switch is in the OFF/CHECK position.

d. Connect the KYK-13 to the side connector (1, Figure 4-3) on the receiver-transmitter via the crypto fill cable (SS-3500280-501).

e. Place the KYK-13 mode switch in the ON position.

f. Using the mode switch on the KYK-13, select one of the six keys to be loaded into the hand-held radio.

g. Press and release the PTT switch on the hand-held radio while watching the red LED on the KYK-13. Confirm that the red LED on the KYK-13 flashes, indicating a successful transfer.

h. To load additional keys, select the key position to be loaded on the hand-held radio mode switch and repeat steps f and g. Note that the KYK-13 has the capacity for six different keys, while the radio can only hold three different TEKs.

i. When key loading is complete, place the KYK-13 mode switch in the OFF/CHECK position and disconnect the fill cable.

j. Attempt to communicate with a newly loaded key to confirm a successful key load. (The amber LED (2, Figure 4-1) will not illuminate in the secure mode.)

4-5.3 Loading Key From AN/CYZ-10 Into Hand-Held Radio.

The AN/CYZ-10 Data Transfer Device (DTD) is a hand-held device that is used for display, key preparation, key transmission, key reception, key storage, and key accountability functions. The DTD has a 2 line by 24 character display and a 35 key keyboard. In one of its applications, the DTD can emulate the the functionality of the common fill devices KOI-18, KYX-15, and KYK-13 to load key into the hand-held radio via the crypto fill cable (SS-3500280-501). Complete operating instructions for the DTD are contained in ON477340, Data Transfer Device Users' Manual.

4-6 TRANSMITTING MESSAGE.

Transmit a message as follows:

a. Perform the initial power-up procedure of paragraph 4-3 to turn on the receiver-transmitter to prepare it for operation.

b. Using the operating mode switch (5, Figure 4-1), select the desired operating mode. If CLR (clear) is selected, the receiver-transmitter bypasses the encryption circuits. If secure mode (codes B, C, or D) is selected, the receiver-transmitter encrypts the secure signal.

c. Use the power/volume switch (3, Figure 4-1) to select desired volume level. Set the volume switch to the two lowest levels to select whisper mode, which provides additional amplification of input volume. Turn the volume switch clockwise to the remaining positions to progressively increase the audio volume.

d. Press and hold the PTT switch on the audio accessory.

e. This places the receiver-transmitter in the transmit mode. Observe that the green transmit LED (1, Figure 4-1) is illuminated to verify proper transmit operation.

NOTE
COMMUNICATIONS SECURITY

When transmitting in secure mode, wait approximately 0.5 second after depressing the PTT switch before beginning to speak. This allows sufficient time for transmission of the COMSEC preamble.

f. The beep tones and the amber LED will flash while transmitting a clear message.

g. While holding the PTT switch depressed, speak into the audio accessory microphone.

4-7 RECEIVING MESSAGE.

The receiver-transmitter can receive a message any time it is turned on and not transmitting. Receive messages as follows:

a. Perform procedures of paragraphs 4-3, 4-4, and 4-5 to turn on the receiver-transmitter and prepare it for operation.

b. Using the operating mode switch (5, Figure 4-1), select the desired operating mode. If CLR (clear) is selected, the receiver-transmitter bypasses the decryption circuits. If secure mode (codes B, C, or D) is selected, the receiver-transmitter decrypts the secure signal.

c. Use the power/volume switch (3, Figure 4-1) to select desired volume level. Turn the volume switch clockwise to the remaining positions to progressively increase the audio volume.

d. When receiving a clear signal, a short-beep warning tone is sounded and the amber LED blinks continuously. This applies whether the receiver-transmitter is set for clear or secure operation. Clear transmissions made on the current operating frequency can be received even if the receiving receiver-transmitter is operating in secure modes B, C, or D.

e. Select desired squelch as follows:

(1) Press the side mounted squelch override switch (2, Figure 4-2) to disable the squelch. Squelch is opened and a continuous rushing noise is heard. Disabling the squelch increases receive sensitivity and allows reception of weak signals.

(2) Press the squelch override switch again to close the squelch. The rushing noise stops.

4-8 SELECT SCAN MODE.

Select SCAN mode as follows:

a. Place the SCAN enable/disable switch (7, Figure 4-1) in the SCAN position to select scan mode.

b. Observe that the green transmit LED (1, Figure 4-1) flashes, indicating that scan mode has been selected.

c. Verify that the receiver-transmitter, when not transmitting, periodically scans for activity on the priority channel (channel 1) by listening for the scan mode audible signal. (See Table 4-2 for description.)

NOTE

If an RF signal is detected on channel 1, an audible signal will be sounded to alert the operator. (See Table 4-2 for description.)

d. Place the SCAN switch in the position opposite SCAN to disable the scan mode.

4-9 SELECTING PRE-PROGRAMMED CHANNELS.

Use the rotary channel select switch (4, Figure 4-1) to select a pre-programmed channel (1 through 14). Channel 1 is reserved for priority use in conjunction with the scan function when scanning is enabled.

4-10 SELECTING KEYS.

Select keys as follows:

NOTE

The receiving receiver-transmitter can decrypt a secure message only if it uses the same key that is used by the transmitting receiver-transmitter. Keys are loaded directly into the COMSEC chip from a KOI-18, KYK-13, or AN/CYZ-10 as described in paragraph 4-5, or from a KYX-15A via over-the-air rekey.

a. Ensure that a charged battery is connected to the receiver-transmitter.

b. Using the power/volume switch (3, Figure 4-1), turn the receiver-transmitter on.

c. Initialize the key load sequence by momentarily pressing the PTT switch (3, Figure 4-2). Key variables B, C, and D contain the traffic encryption keys (TEKs) to encrypt voice transmissions. Key variable A contains the key encryption key (KEK) used only for receive Saville Advanced Remote Keying (SARK) operations.

4-11 CLONE HAND-HELD RADIO PROGRAMMING INFORMATION.

The cloning mode enables one hand-held radio to transfer its programmed data into another hand-held radio. The source hand-held radio must have cloning enabled as either master, slave or no change (see Appendix A) in order to transfer data. Transfer data to another hand-held radio as follows:

NOTE

Crypto keys cannot be transferred via the cloning mode.

a. Connect a cloning cable (P/N SS-3500272-501) between the side connector (1, Figure 4-3) of the source hand-held radio (the hand-held radio with the information to be cloned) and the audio accessory connector (2, Figure 4-3) of the target hand-held radio (the hand-held radio to receive the information).

b. Turn on power to both hand-held radios using the appropriate power/volume switch (3, Figure 4-1).

c. Observe that the green transmit LED (1, Figure 4-1) on the source hand-held radio illuminates continuously.

d. Press and release the PTT switch (3, Figure 4-2) on the source hand-held radio.

e. Observe that the green transmit LED on the source hand-held radio flashes for 4 or 5 seconds. This indicates that data is being transferred. The transmit LED should then illuminate continuously to indicate a successful cloning.

NOTE

If the green transmit LED does not flash during cloning or if the LED goes off after flashing, cloning was unsuccessful and must be re-attempted.

4-12 KEY ZEROIZE.

Zeroize all keys stored in the hand-held radio as follows:

a. Press and hold the mechanical interlock (6, Figure 4-1). While holding the mechanical interlock depressed, briefly set the operating mode switch (5, Figure 4-1) to the Z (zeroize) position. An alarm should be heard after zeroization. Secure communications are no longer possible until keys are loaded with an appropriate COMSEC fill device.

NOTE

The zeroize function can be performed without power being supplied to the hand-held radio (power/volume turned to OFF) or without a battery being connected. Key zeroize can *only* be performed by using the operating mode switch or by allowing the key retention time (minimum 90 seconds or maximum 300 seconds) to expire when the battery is disconnected.

4-13 EQUIPMENT SUTDOWN.

Shut down the hand-held radio as follows:

a. Place the power/volume switch (3, Figure 4-1) in the OFF position.

b. Verify that the hand-held radio is off by pressing the audio accessory PTT switch and confirm that the green transmit LED (1, Figure 4-1) is not illuminated.

Section III. EMERGENCY OPERATION

4-14 ELECTROMAGNETIC PULSE PROTECTION.

Electromagnetic Pulse (EMP) is a pulse of broad bandwidth, high amplitude radio frequency electromagnetic energy produced by the radiation from a nuclear burst.

4-14.1 EMP Susceptibility.

EMP can deliver a power density to a radio receiver a billion times greater than the power necessary for reception. The voltage and current surges resulting from EMP can overload most modern solid state electronic devices.

4-14.2 EMP Protective Measures.

All equipment not absolutely required in primary systems should remain disconnected and stored within a sealed shelter or other shielded enclosure for protection from EMP. To prevent or reduce "coupling" with the energy from EMP, wires and cables (to include output coaxial types) should be shielded and properly grounded. Lengths of cables should be kept as short as possible. Excess lengths of cable in use should never be left wound on a cable reel but should be pulled out in a straight line to avoid having loops in the cables. When cables are not needed, they should not be connected to the equipment. Burying cables a foot or more will reduce their exposure to EMP fields. Antennas and their connecting cables should be disconnected from radio sets when not in use. Narrow bandwidth antennas requiring high power for operation reduce the EMP coupling effect.

4-15 NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) CONTAMINATION.

The Scope Shield equipment has a Chemical Agent Resistant Coating (CARC) finish that reduces the susceptibility to NBC contamination. However, in the event the equipment does become contaminated, great care must be exercised in performing decontamination before the equipment can be returned to use. The power suplly must be disconnected to prevent personnel injury and equipment damage. The best way tio decontaminate communications equipment is with hot air, although metal surfaces exposed to blister agents and V-agents may be decontaminated with DS2.

WARNING

DS2 is highly corrosive and must be used with extreme care to avoid rendering equipment inoperable.

CHAPTER 5. THEORY OF OPERATION

Section I. FUNCTIONAL SYSTEM(S) OPERATION

5-1 GENERAL.

This section describes the theory of operation of the hand-held radio. From both technical and operational standpoints, the hand-held radio is designed to be a component of a communications system. A hand-held radio must function in conjunction with other similar FM radios to perform its purpose: two-way communication. However, it does not depend on other radios for its proper functioning or performance.

When operating in the secure mode, the hand-held converts analog voice to 12 or 16 kbps (Continuous Variable Slope Delta) (CVSD) digitized voice. This is encrypted in such a manner that allows the hand-held radio to communicate with other radios that are VINSON compatible and operating at 16 kbps. The hand-held radio obtains this interoperability with an embedded INDICTOR COMSEC module. The hand-held radio also operates at 12 kbps compatible with FED-STD-1023.

5-2 FUNCTIONAL SYSTEM(S) OPERATION.

(See Figure 5-1.) Paragraphs 5-2.1 through 5-2.6 provide a limited system description of the hand-held radio. The functional block diagram (Figure 5-1) shows the interrelationship between the main elements of the hand-held radio. An interconnection diagram for the hand-held radio is shown in FO-6.

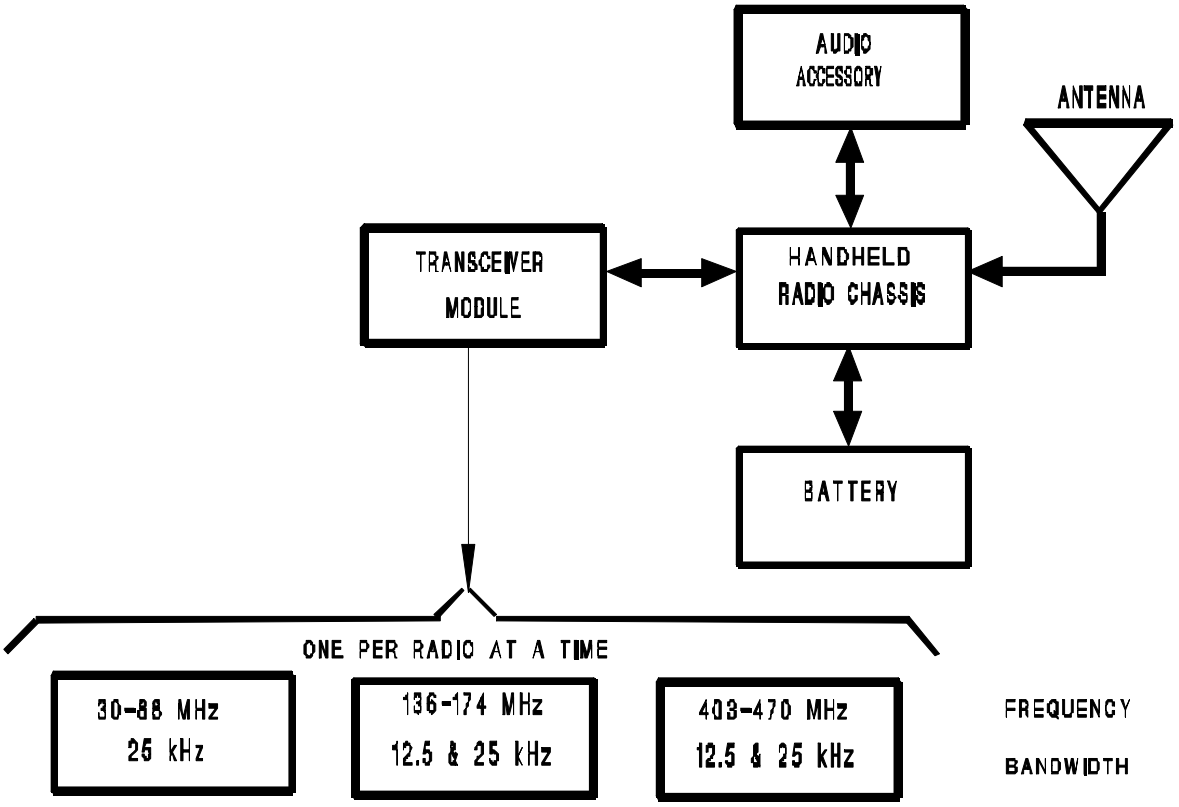


Figure 5-1. Hand-Held Radio, Simplified Block Diagram

5-2.1 Transceiver Module.

The transceiver module is enclosed within the receiver-transmitter module. There are three transceiver modules supplied with the receiver-transmitters that operate in the following frequency bands:

a. 30-88 MHz tactical (T-band)
b. 136-174 MHz high (H-band)
c. 403-470 MHz ultra-high frequency (U-band)

One of these three transceiver modules must be selected and installed for use in the receiver-transmitter. The transceiver module provides frequency and change-over control for either transmitting or receiving a signal, as well as the modulator and power amplifier for the receiver-transmitter. The transceiver module mates with the hand-held radio chassis to complete the receiver-transmitter assembly.

5-2.2 Hand-Held Radio Chassis Assembly.

The hand-held radio chassis consists of the control circuit card assembly (CCA), the crypto CCA, and the chassis assembly.

5-2.2.1 Control CCA.

The control CCA is a multi-layered, printed circuit board with both through-hole and surface mount components. The control CCA is mounted in the hand-held radio chassis.

The control CCA provides regulated DC power, control logic, audio amplification, volume control, and the transmit modulation buffer for the receiver-transmitter. The control CCA mounts in the center of the hand-held radio chassis. The control CCA internally interfaces with the transceiver module and crypto CCA within the receiver-transmitter. The control CCA provides operator interface via four of the five control panel switches (power/volume, PTT, squelch override, channel, and scan select) and through the audio connector.

5-2.2.2 Crypto CCA.

The crypto CCA is a surface mount, printed circuit board directly mounted to the hand-held radio chassis. The crypto CCA contains the on-board INDICTOR COMSEC device that is used to provide encryption and decryption of digitized voice signals (VINSON coded or FED-STD-1023). The COMSEC device stores the key data information that is used to provide the crypto capability within the receiver-transmitter. The crypto CCA controls the selection of transmit and receive audio signal processing in both the clear and encrypted modes. The crypto CCA provides operator interface via the control panel mode switch and the PTT switch.

The crypto CCA utilizes individual, separated power circuits for clear and encrypted signals. Since key data is lost when power to the receiver-transmitter is removed, the crypto CCA contains a hold-up capacitor that provides 90 seconds of assured key retention backup before clearing the crypto key data after the battery is removed. Key data may only be cleared manually by turning the operating mode switch to Z (zeroize). This zeroize function can be performed with or without the receiver-transmitter being turned on.

5-2.3 Rechargeable NiCad Battery.

The rechargeable Nickel Cadmium (NiCad) battery provides attachable battery power to the receiver-transmitter (see Figure 2-2). The NiCad is a renewable energy battery which can be recharged by the single and multiple battery chargers. It provides 12 hours of operation with a 1/1/8 transmit to receive to standby (power on but neither receiving nor transmitting) ratio duty cycle at 25°C.

CAUTION

Lithium oxide batteries are potentially hazardous if misused or tampered with before, during, or after discharge. Observe the precautions listed in the Safety Summary of this manual.

5-2.4 Non-Rechargeable Lithium Battery.

The non-rechargeable Lithium battery provides attachable battery power to the receiver-transmitter in a disposable energy battery. It is similar in shape and function to the rechargeable NiCad battery, but provides 24 hours of operation with a

1/1/8 transmit to receive to standby ratio duty cycle at 25°C. Each Lithium battery contains approximately 4 grams of Lithium Oxide.

5-2.5 Palm Handset.

The palm handset is a combination noise-canceling microphone/speaker with a frequency response from 300 - 3500 Hertz (Hz). The handset is equipped with a push-to-talk (PTT) switch and is less than 3.4 in. x 2.2 in. x 1.5 in. in size. The handset has a 30 in. shielded cord with a U329/U connector. Because the receiver-transmitter does not have an internal speaker or microphone, the palm handset (or other optional audio accessory) must be used with the receiver-transmitter.

5-2.6 Hand-Held Radio Accessories.

Hand-held radio accessories are described in the following paragraphs.

5-2.6.1 Multiple and Single Station Battery Chargers.

Refer to Appendix B for detailed discussion of the multiple and single station battery chargers.

5-2.6.2 Handset H-250/U.

The H-250/U handset is a standard U.S. Government inventory item. The handset is intended for use on a variety of field receiver-transmitters and digitally encrypted voice terminals to provide communications under conditions encountered in the field. The H-250/U is not water resistant.

5-2.6.3 Headset, Ear Microphone.

The ear microphone is an optional audio accessory which allows the operator to discretely monitor/send receiver-transmitter transmissions with a small combination microphone/speaker which fits into the operator's outer ear canal (similar to a hearing aid). The small size of the ear microphone allows it to be worn with all types of battlefield helmets. The headset also has a belt-mounted interface box with a switch, and a ring-mounted PTT switch. The headset uses a standard U329/U connector with the following pin connections:

a. Ground
b. Audio to headphone
c. Push-To-Talk (PTT)
d. Microphone out
e. No Connection (N/C)
f. +10 VDC (nominal)

5-2.6.4 Battery Reconditioner.

Refer to Appendix B for detailed discussion of the battery reconditioner.

5-2.6.5 Frequency Fill Device.

The frequency fill device provides a means of viewing and changing the hand-held radio programmable parameters, such as output power, channel frequencies, and squelch levels. A complete description, as well as operation and maintenance procedures, is contained in Appendix A of this TO.

Section II. FUNCTIONAL OPERATION OF ELECTRONIC CIRCUITS

5-3 TACTICAL BAND (30-88 MHz) TRANSCEIVER MODULE.

The tactical band transceiver module is one of three RF modules which can be fitted to the receiver-transmitter. The receiver-transmitter allows changing from one band to another by simply changing the transceiver module and antenna. Refer to FO-1 for the block diagram for the tactical band (30-88 MHz) transceiver module. As shown in FO-1, the tactical band transceiver module consists of the following functional elements:

a. Bandpass filters
b. Receiver circuits
   (1) Front end protection
   (2) RF amplifiers and notch filters
   (3) First mixer
   (4) First intermediate frequency (IF) filter and amplifier
   (5) Second mixer, IF limiter, and detector

(6) Squelch circuit
c. Transmitter
d. Automatic level control (ALC)

e. Synthesizer
(1) Receiver VCO
(2) Transmitter VCO
(3) Reference oscillator
(4) Frequency dividers and phase detector
(5) Loop filter
(6) Lock detector
f. Modulation
g. Voltage multiplier
h. Voltage references
i. Supply switching
j. Control functions
k. Temperature sensor
l. EEPROM

The tactical band transceiver module implements a nominal 2 watt VHF FM synthesized transceiver in the 30 to 88 MHz frequency band. The transceiver module contains the synthesizer, transmitter and receiver circuits together with their associated control circuits and an EEPROM used to hold calibration data and other non-volatile data.

The transceiver module has two radio frequency (RF) connections, one for the top panel TNC connector on the receiver-transmitter and one for the receiver-transmitter side connector. Switching between the two connections is accomplished by a relay.

Immediately following the relay is a bank of four bandpass filters. The required filter for the frequency in use is selected by means of PIN diodes; the diodes also serve as RF Tx/Rx switching.

In receive mode the incoming RF signal is routed from the bandpass filters to a notch filter which rejects the first IF of 21.4 MHz. The IF notch filter is followed by two stages of RF amplification, after which the signal passes to the first mixer via a tuneable notch filter which rejects the image frequency. The first mixer is an active double balanced device in which the RF is mixed with the local oscillator (LO) from the synthesizer. The difference frequency of 21.4 MHz is passed through a crystal filter to an IF amplifier stage. The 21.4 MHz IF is then further mixed with the second LO (at 21.855 MHz). The difference frequency of 455 kHz (second IF) is passed through a ceramic filter. Following the ceramic filter is a high gain limiting amplifier.

The limited second IF is then split, one part feeding a quadrature detector directly, and the other part feeding the detector via a frequency sensitive phase shifting network.

The recovered (FM detected) audio signal is then amplified before being exported on the 24-way edge connector.
A small sample of the limited second IF signal is fed to the squelch circuit. The squelch circuit produces logic level pulses whose frequency is inversely proportional to the received signal to noise ratio.
In the transmit mode, the RF is generated by the transmit VCO which is buffered and fed to an amplifier stage. The output of this amplifier feeds a push-pull driver stage which feeds the push-pull power amplifier (PA) stage. The output of the PA is fed via band-pass filters to the RF connector via the side/TNC relay.

The output power of the module is held constant by an automatic level control (ALC) circuit which acts to keep the PA current constant. The output power can be varied by means of a control signal into the ALC to enable the power across the band to be levelled and to allow the selection of 1/2W or 2W output. Control of the PA output is achieved by varying the drive to the PA which is achieved by varying the class of operation of the driver stage. In the receive mode, the synthesizer provides a LO signal for the receiver at 21.4 MHz higher than the wanted Rx frequency. In the transmit mode, it provides a frequency modulated drive at the output frequency. The synthesizer comprises two voltage controlled oscillators (VCOs), one for transmit and one for receive, a prescaler/synthesizer chip set, an active loop filter as well as the RF outputs. The synthesizer also provides a 6.25 kHz reference frequency which is exported for use in a base station.

Other items contained within the transceiver module include a voltage multiplier circuit to generate the high voltage for stages using varactor diodes and an EEPROM which contains calibration data specific to an individual module along with other receiver-transmitter data such as channel frequency information.

5-4 HIGH BAND (136-174 MHz) TRANSCEIVER MODULE.

The high band transceiver module is one of three RF modules that can be fitted to the receiver-transmitter. The receiver-transmitter allows changing from one band to another by simply changing the transceiver module. Refer to FO-2 for the block diagram for the high band (136-174 MHz) transceiver module. As shown in FO-2, the high band transceiver module consists of the following functional entities:

a. Antenna and associated circuitry
   (1) Antenna switching
   (2) Bandpass filter
b. Receiver
   (1) Receiver front end protection
   (2) Notch filter
   (3) RF amplifier
   (4) Image notch filter
   (5) First mixer
   (6) First IF amplifier
   (7) Second mixer - local oscillator
   (8) Second IF bandwidth selection
   (9) Second IF detector
   (10) Carrier squelch
c. Synthesizer
   (1) Reference oscillator
   (2) Voltage controlled oscillator
   (3) Dual modulus prescaler
   (4) Dividers/phase detector
   (5) Loop filter
   (6) Lock detector
d. Transmitter
   (1) Buffer
   (2) Pre-driver stage
   (3) Driver stage
   (4) Output stage
   (5) Automatic level control (ALC)
e. Digital interface
   (1) Digital-to-analog converter (DAC)
   (2) EEPROM
   (3) Shift Register
f. Miscellaneous functions
   (1) Temperature sensor
   (2) Precision voltage reference
   (3) Voltage multiplier
   (4) Power supply switching
   (5) Transmit mode
   (6) Receive mode

The high band transceiver module implements a nominal 2 watt VHF FM synthesized transceiver in the 136 to 174 MHz frequency band. It is divided into bandpass filter and antenna switching, receiver, transmitter, synthesizer, digital interface, and miscellaneous functions.

The transceiver module has two receiver-transmitter frequency (RF) connections, one for a top panel TNC antenna socket and one for the handheld radio side connector. Both of these connections are routed through to the control CCA via the same connector (PL6). Switching between them is implemented within the module by a relay.

Immediately after this relay is a 136 to 174 MHz bandpass filter used in both transmit and receive modes, and the TX/RX PIN diode switching.

Following the TX/RX switching on the receiver chain is a Digital-to-Analog Convertor (DAC), tuned notch filter (to provide rejection at image/2 frequencies), an RF amplifier, and another DAC tuned notch filter to provide image rejection. This is followed by a dual conversion receiver chain.

Mixing to the first Intermediate Frequency (IF) of 45 MHz is achieved in a passive mixer using high side Local Oscillator (LO) injection from the synthesizer. The first IF stage includes two stages of gain and a crystal filter pair.

Conversion to the second IF of 455 kHz is achieved with an active mixer stage with two outputs that are fed to two different 455 kHz ceramic filters used to define the channel bandwidth for 12.5 kHz and 25 kHz modes.

The output from the selected IF filter is fed to a low power FM IF stage that incorporates two further gain stages and a quadrature FM detector. The audio output is conditioned by a variable gain stage before being passed to the control CCA. The FM IF stage also produces a Received Signal Strength Indicator (RSSI) signal that is also passed to the control CCA. The noise superimposed on this signal's nominal DC level is threshold detected to produce pulses that are used as a carrier squelch indication in the control CCA.

The final output receiver-transmitter frequency is generated by the transmit Voltage Controlled Oscillator (VCO) which is then buffered to reduce frequency pulling effects. This signal is then amplified by a gain controlled pre-driver stage, a driver stage and then a final output stage. The output of the final stage is then fed to a matching network to the TX/RX switching and out through the antenna. The transmitter incorporates an automatic level control (ALC) loop which senses the current taken from the 10 volt supply and controls the gain of the pre-driver stage. The ALC setting is controlled by a combination of a DAC line, control line from the control CCA, an output stage temperature sense circuit and a digital control line from the shift register to select between 1/2 watt and 2 watts.

The synthesizer is implemented with a DAC controlled coarse tuned phase locked loop (PLL) synthesizer using one of two VCO's, a prescaler, synthesizer IC, reference oscillator and loop filter. The synthesizer circuitry also provides a 6.25 kHz reference output and lock status to the control CCA. DAC controlled modulation is applied to both the reference oscillator and the TX VCO. Further DAC control is necessary to temperature compensate the reference oscillator.

The serial digital interface to an Electrically Erasable Programmable Read Only Memory (EEPROM), shift register, 8 channel DAC, and synthesizer is incorporated within this module.

Additional circuits implement power supply switching functions within the module, a precision voltage reference, 20 volt generator for the loop filter and DAC amplifiers and a module temperature sensing function.

5-5 ULTRA HIGH FREQUENCY (UHF) (403-470 MHz) TRANSCEIVER MODULE.

The ultra high frequency (UHF) band transceiver module is one of three RF modules that can be fitted to the receiver-transmitter. The receiver-transmitter allows changing from one band to another by simply changing the transceiver module. Refer to FO-3 for the block diagram for the UHF (403-470 MHz) transceiver module. As shown in FO-3, the UHF transceiver module consists of the following functional entities:

a. RF filtering and switching
b. Signal path switching
c. 500 MHz low pass filter
d. Receiver protection
e. Side connector matching
f. Pin diode bias circuits

g. Transmitter
h. Output stage
i. Automatic leveling control
j. Receiver
k. Synthesizer
l. Control

5-6 CONTROL CIRCUIT CARD ASSEMBLY (CCA).

Refer to FO-4 for the block diagram for the control CCA. As shown in FO-4, the control CCA consists of the following functional elements:

a. On/off switching, supply in/out, and battery protection
b. 7.4V and 5V voltage regulators
c. Supply monitoring and switching
d. Microprocessor reset
e. Microphone inputs
f. Volume control and receive audio circuits
g. Pulse width modulation
h. Temperature circuit
i. Reference frequency control
j. Who Are You (WRU)
k. Receive sub-audible tones
l. Transmit audio
m. Miscellaneous outputs
n. Miscellaneous inputs

5-7 CRYPTO CIRCUIT CARD ASSEMBLY (CCA).

Refer to FO-5 for the block diagram for the crypto CCA. As shown in FO-5, the crypto CCA consists of the following functional elements:

a. Voice operated gain adjustment device (VOGAD)
b. Audio filter
c. De-emphasis squelch tone suppressor
d. Clock recovery
e. Clock generator
f. Continuously variable slope data modulator
g. Transversal filter
h. Power transient detectors
i. Key retention
j. Mode switch circuitry
k. Bypass logic
l. Indicator
m. Power circuits

Section III. FUNCTIONAL OPERATION OF MECHANICAL ASSEMBLIES

Not Applicable.

CHAPTER 6. MAINTENANCE

6-1 GENERAL.

This chapter provides organizational maintenance instructions for the hand-held radio. This includes operational checkout, servicing (inspection and preventive maintenance), troubleshooting, and removal/replacement procedures.

6-2 OPERATIONAL CHECKOUT.

Perform the procedures in paragraphs 6-2.1 through 6-2.10 to check the hand-held radio for normal operation. These checks should be performed when equipment is used for the first time, or when there is a possibility that the equipment has been damaged. If the hand-held radio fails any of the checks, refer to paragraph 6-4 for troubleshooting procedures.

NOTE

Prior to conducting the operational checkout, the hand-held radios used in the test shall be properly programmed and configured, to include loading of COMSEC keys. Refer to paragraph 4-4 for programming instructions. Refer to paragraph 4-5 for COMSEC key loading. Remote unit refers to another hand-held radio which the unit under test can either transmit to or receive from.

NOTE

While performing the initial power-up verification and transmission test procedures, the hand-held radio will radiate RF energy which can cause frequency interference. Do not perform the following check-out procedures before the frequency use authorization is effective.

6-2.1 Power-up Verification.

Check the receiver-transmitter power-up operation as follows:

a. Connect the palm handset (or other audio accessory) to the audio accessory connector (2, Figure 4-3).

b. Turn the power/volume switch (3, Figure 4-1) to mid-range position.

c. With the hand-held radio in standby mode (not transmitting or receiving), verify that short beeps of noise are not heard (low battery warning). (See Table 4-2.)

d. Press the side mounted squelch override switch (2, Figure 4-2) to disable the squelch. Verify that a continuous rushing noise is heard. (See Table 6-2.)

e. Press the squelch override switch again to close the squelch. Verify that the rushing noise stops. (See Table 6-2.)

f. Press the PTT switch (3, Figure 4-2) on the audio accessory and verify that the green transmit LED (1, Figure 4-1) illuminates continuously. See Table 6-2.

g. If the transmit LED fails to illuminate or flashes a low battery warning (see Table 4-2), replace the battery and repeat the power-up verification procedure. If the check fails a second time, the hand-held radio may require corrective maintenance. Refer to paragraph 6-4 for troubleshooting procedures.

NOTE

The transmit current drain (with PTT switch pressed) is significantly greater than standby current drain (neither transmitting nor receiving). This increased drain may cause the low battery warning to flash if a marginal battery is attached.

6-2.2 Clear Mode Reception Test.

Set the local and remote hand-held radios for clear (unencrypted) operation (operating mode switches set to CLR), with local frequency same as remote unit transmit frequency, and normal volume setting (mid-range). Transmit a test message from the remote unit. At the local unit:

a. Confirm undistorted voice reception - short beeps and flashing amber LED (2, Figure 4-1).

b. Confirm correct voice outputs levels over the range of all six settings of the power/volume switch (3, Figure 4-1).

NOTE

The remote radio should remain in clear mode for this entire test.

c. Set the operating mode switch (5, Figure 4-1) of the local radio to position D (secure mode). Confirm undistorted voice reception - short beeps and flashing amber LED.

d. Set the operating mode switch of the local radio to position C. Confirm undistorted voice reception with short beeps and flashing amber LED.

e. Set the operating mode switch of the local radio to position B. Confirm undistorted voice reception with short beeps and flashing amber LED.

6-2.3 Clear Mode Transmission Test.

Set the local hand-held radio power/volume switch to mid-range and the operating mode switch to CLR; press and hold the PTT switch on the audio accessory. Transmit a test message from the local hand-held radio. At the local hand-held radio:

a. Verify that the green transmit LED (1, Figure 4-1) illuminates, a short beep warning tone is heard, and the amber LED flashes.

b. Verify that a rapid beep warning tone is heard during the last 5 seconds before the transmit period time-out. (Only if hand-held radio has been programmed for transmit time-out.)

c. Verify that the transmit LED is no longer lit and a continuous two-tone warning is heard after time-out.

d. Release PTT and verify the two-tone warning signal stops.

e. Verify that the transmitted message was received satisfactorily at the remote hand-held radio.

6-2.4 Whisper Mode Check.

Check the hand-held radio whisper mode as follows:

a. Transmit a test message from the local hand-held radio using whisper mode. Set the volume switch to the first position and whisper into the microphone. Verify satisfactory reception at the remote hand-held radio.

b. Repeat the whisper transmission with the volume switch set to the second position. Verify satisfactory reception at the remote hand-held radio.

6-2.5 Channels 2 through 14 Functional Check.

Repeat the clear mode receive and transmit tests (paragraph 6-2.2 and 6-2.3) for channels 2 through 14, if used.

6-2.6 Encrypted Reception Test.

On the local hand-held radio, load TEST KEY into key locations B, C, and D from a KYK-13 or KOI-18. Ensure that the remote hand-held radio is programmed with same channels and keys. Set both units to channel 2, mid-range volume. At the local hand-held radio, set the operating mode switch (5, Figure 4-1) to CLR. At the remote hand-held radio, set the mode switch to position B and transmit a test message.

a. Verify that rushing noise is heard at the local hand-held radio.

b. Set the local hand-held radio mode switch to position B. Verify that slightly distorted audio is heard, the amber LED is not flashing, and no beep tones are heard.

c. At the remote hand-held radio, interrupt transmission and set the operating mode switch to position C.

d. At the local hand-held radio, set the mode switch to position C. Transmit a test message from the remote hand-held radio. Verify that slightly distorted audio is heard at the local unit, the amber LED is not flashing, and no beep tones are heard.

e. At the remote hand-held radio, interrupt transmission and set the operating mode switch to position D.

f. At the local hand-held radio, set the operating mode switch to position D. Transmit a test message from the remote hand-held radio. Verify that slightly distorted audio is heard at the local hand-held radio, the amber LED (2, Figure 4-1) is not flashing, and no beep tones are heard.

6-2.7 Encrypted Transmission Test.

On the local hand-held radio, load TEST KEY into key locations B, C, and D from a KYK-13 or KOI-18. Ensure that the remote hand-held radio is programmed with same channels and keys. Set both units to channel 2, mid-range volume. At the remote hand-held radio, set the operating mode switch (5, Figure 4-1) to CLR. At the local hand-held radio, set the mode switch to position B and transmit a test message.

a. Verify that rushing noise is heard at the remote hand-held radio.

b. Set the remote hand-held radio mode switch to position B and transmit a test message from the local radio. Verify that slightly distorted audio is heard, the amber LED is not flashing, and no beep tones are heard.

c. At the local hand-held radio, interrupt transmission and set the operating mode switch to position C.

d. At the remote hand-held radio, set the mode switch to position C. Transmit a test message from the local hand-held radio. Verify that slightly distorted audio is heard at the remote unit, the amber LED is not flashing, and no beep tones are heard.

e. At the local hand-held radio, interrupt transmission and set the operating mode switch to position D.

f. At the remote hand-held radio, set the operating mode switch to position D. Transmit a test message from the local hand-held radio. Verify that slightly distorted audio is heard at the remote hand-held radio, the amber LED (2, Figure 4-1) is not flashing, and no beep tones are heard.

6-2.8 Key Retention Check.

At the local unit, set the power/volume switch to OFF and remove the battery. Within 90 seconds, re-attach the battery and turn the power/volume switch to a mid-range position. Repeat the encrypted reception test (see paragraph 6-2.6) on one key and verify satisfactory secure communications with the remote hand-held to confirm that the stored keys have been retained. If the hand-held radio fails to retain key, refer to the organizational maintenance guide, Table 6-2.

6-2.9 Key Zeroize Check.

Press the mechanical interlock on the local hand-held radio to release it and place the operating mode switch in the Z position. Then set the mode switch to B position.

a. Verify that a continuous alarm is heard immediately. Press and release PTT (either on the audio accessory or on the side of the hand-held radio) until the tone is cleared.

b. Press PTT and transmit a test message while monitoring the green transmit LED (1, Figure 4-1). Verify that the hand-held radio does not transmit a modulated signal (i.e., no voice or white noise is heard at remote hand-held radio). Verify that the green transmit LED on the local hand-held radio lights momentarily, then turns off.

c. Release the PTT and verify that the alarm is heard.

d. Press and release PTT again to clear the alarm.

e. Set the operating mode switch of the local hand-held radio to position C and repeat steps b and c above.

f. Set the operating mode switch of the local hand-held radio to position D and repeat steps b and c above.

6-2.10 Battery Check.

Connect one of the transceiver audio accessories to the receiver-transmitter and proceed as follows:

a. Set the power/volume switch to maximum volume. In the standby mode (not transmitting or receiving), confirm that short beeps of noise are not heard.

b. Press the squelch override switch (2, Figure 4-2) to open squelch and verify that rushing noise (white noise) is heard.

c. Press PTT and verify that the green transmit indicator (1, Figure 4-1) illuminates continuously (i.e., it does not flash during transmission) and that there is no low battery audible alarm.

d. If the test fails, change the battery and repeat the tests.

6-2.11 Scan Mode Check.

Set the remote hand-held radio to channel 1. Ensure that the local hand-held radio has the same frequencies and keys as the remote hand-held radio. Set the local hand-held radio to any channel other than 1. Place the mode switch on both units to the CLR position.

a. Set the local hand-held radio into the scan mode by placing the scan switch in the SCAN (up) position. Verify that the green transmit LED (1, Figure 4-1) flashes.

b. At the remote hand-held radio, transmit a test message over channel 1.

c. Verify that the local hand-held radio signals activity on the priority channel by sounding an audible warning tone. (See Table 4-2.)

6-3 SERVICING.

6-3.1 Servicing Intervals.

Table 6-1 provides recommended service intervals.

Table 6-1. Recommended Service Intervals

Task	Recommended Interval			
	D	W	M	Q
Visual inspection (see paragraph 6-3.2)	X			
Preventive maintenance:				
Inspection (see paragraph 6-3.3.1)		X		
Cleaning (see paragraph 6-3.3.2)		X		

D = Daily M = Monthly

W = Weekly Q = Quarterly

6-3.2 Inspection.

Many potential or existing faults can be detected by making a visual inspection of the equipment. For this reason, a complete visual inspection should be made on a routine basis and whenever the hand-held radio is inoperative.

NOTE

If any discrepancies are observed, return the equipment to higher level maintenance.

At a minimum, the following items should be inspected by the operator and/or repair specialist:

a. Inspect the equipment covers and front panel for condition of finish and panel markings.
b. Inspect for dents, punctures, and warped areas.
c. Inspect external surfaces for loose or missing screws or washers.
d. Inspect receptacles and connectors for condition of pins, contacts, and mounting.
e. Inspect control knob and switches for mechanical integrity.
f. Inspect audio accessories for signs of abrasion and wear.
g. Inspect antenna for signs of physical damage or wear.
h. Inspect battery connections to ensure that they are clean and free of dirt.

6-3.3 Preventive Maintenance.

The hand-held radio requires very little routine maintenance other than inspection and cleaning. At regular intervals (see Table 6-1), the operator shall perform the following procedures:

6-3.3.1 Inspection.

Inspect the hand-held radio as follows:

a. Inspect the equipment covers and front panel for condition of finish and panel markings.
b. Inspect the unit for dents, punctures, and warped areas.
c. Inspect external surfaces for loose or missing screws or washers.
d. Inspect receptacles and connectors for condition of pins, contacts, and mounting.
e. Inspect the knobs and switches for mechanical integrity.
f. Inspect audio accessories for signs of abrasion and wear.
g. Inspect antenna for signs of physical damage or wear.
h. Inspect battery connections to ensure that they are clean and free of dirt.
i. Inspect LEDs for dust accumulation.

6-3.3.2 Cleaning

Cleaning should be performed to remove accumulated dust and other contaminants. Clean the hand-held radio as follows:

a. Dust the switches and LEDs with a soft-bristled brush.

b. Remove any dirt adhering to the hand-held radio with a clean, lint-free cloth dampened with a mild detergent and water solution. Avoid using abrasive cleaners, as they will scratch the hand-held radio's surface.

c. Use a soft pencil eraser to clean the radio side connector contacts.

6-4 TROUBLESHOOTING.

Tables 6-2 and 6-3 describe possible system malfunctions, their probable cause(s), and corrective action required by the operator/repair specialist to return the equipment to a fully operational state. All solutions which suggest replacement of an item assume that the item used to make the replacement is a known good item.

Table 6-2 contains symptoms of possible system malfunctions which can be acted on by the operator. Only those procedures contained within Table 6-2 are authorized to be performed by the operator. Troubleshooting procedures contained in Tables 6-2 and 6-3 are authorized to be performed by the repair specialist. Table 6-4 provides a cross-reference to applicable removal/replacement procedures

At a minimum, the following items should be inspected by the repair specialist when examining a malfunctioning receiver-transmitter:

a. The repair specialist should reinspect those items that were inspected by the operator.

b. Inspect the internal components for signs of deterioration, discoloration, or charring. Check for melted insulation and damaged, cracked or broken components.

c. Inspect the printed circuit boards for damaged tracks, loose connections, corrosion, or other signs of deterioration.

d. Inspect the printed circuit (PC) connectors, interface connectors, and chassis wiring for excessive wear, looseness, misalignment, corrosion, or other signs of deterioration.

Before referring to Tables 6-2 or 6-3, refer to Tables 4-5 and 4-6 to ensure that the hand-held radio is correctly programmed, including loading of COMSEC keys, all controls are properly set, and that a matching configuration of transceiver module and antenna is installed. Verification of the radio programming can be performed with the frequency fill device as described in paragraph A1-3 of Appendix A.

After each repair action, the repair specialist should perform the operational checkout described in paragraph 6-2.

Table 6-2. Organizational Maintenance Guide - Operator

Symptom	Possible cause	Remedy
Hand-held radio does not receive and/or transmit and the LEDs do not light	Bad battery	Recharge/recondition battery (see paragraph B1-3). If trouble persists, replace battery.
	Bad or no programming	Load programming information from a frequency fill device, base station, or master receiver-transmitter
	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Hand-held radio alarms when operating in the secure mode	Bad or no key	Load key
	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
LEDs do not light properly; however all other functions are operative	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Channel select switch does not change the channel	Bad or no programming	Load programming information from a frequency fill device, base station or master receiver-transmitter
	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Hand-held radio does not receive and/or transmit, but LEDs function properly	Bad or no programming	Load programming information from a frequency fill device programmer, base station or master receiver-transmitter
	Bad battery	Recharge/recondition/replace battery
	Failed audio accessory	Replace audio accessory
	Failed antenna	Replace antenna
	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Hand-held radio does not receive and/or transmit and the green transmit LED flashes rapidly	No frequency data loaded	Load frequency data using frequency fill device, base station, or master receiver-transmitter
	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Hand-held radio receives and/or transmits; however range is severely reduced	Mismatched antenna	Ensure proper antenna installed (same as transceiver module)
	Discharged or weak battery	Recharge/recondition/replace battery
	Failed antenna	Replace antenna
	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair

Table 6-2. Organizational Maintenance Guide - Operator - CONT

Symptom	Possible Cause	Remedy
Hand-held radio will not function in the secure mode	Wrong key loaded/selected	Load/select proper key
	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Mode switch does not change the COMSEC mode	Bad or no key	Load key
	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Volume switch does not change the Volume	Discharged or bad battery	Recharge/recondition/replace battery.
	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Hand-held radio alarms in clear mode and does not transmit	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Hand-held radio transmits OK, but with low transmit audio	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Squelch switch does not function	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Hand-held radio does not accept programming data from the frequency fill device, the base station or via cloning	Fault cannot be isolated/repaired by the operator	Return the system to repair specialist for repair
Radio malfunction/error alarm	Secure mode selected, but no key loaded/selected	Load/select crypto key
	Fault cannot be isolated/repaired by the operator	Return the system to the repair specialist for repair
Low battery warning	Discharged or weak battery	Recharge/recondition/replace battery .
	Fault cannot be isolated/repaired by the operator	Return the system to the repair specialist for repair
TX time-out impending	Length of transmission is within 5 seconds of programmed transmit time-out	Release PTT and re-key if further transmission is needed/desired
	Fault cannot be isolated/repaired by the operator	Return the system to the repair specialist for repair
Crypto alarm	Fault cannot be isolated/repaired by the operator	Return the system to the repair specialist for repair
Unable to power radio through side connector (radio does not function when installed in vehicle adapter.)	Defective hand-held radio chassis	Return the hand-held radio chassis to the repair specialist for repair

Table 6-3. Organizational Maintenance Guide - Repair Specialist

Symptom	Possible Cause	Remedy
Hand-held radio does not receive and/or transmit and the LEDs do not light	Failed hand-held radio chassis	Replace hand-held radio chassis
	Failed transceiver module	Replace transceiver module
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot for repair
Hand-held radio alarms when operating in the secure mode	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot for repair
LEDs do not light properly; however all other functions are operative	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot for repair
Channel select switch does not change the channel	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot for repair
Hand-held radio does not receive and/or transmit, but LEDs function properly	Failed transceiver module	Replace transceiver module
	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot for repair
Hand-held radio does not receive and/or transmit and the green transmit LED flashes rapidly	Failed transceiver module	Replace transceiver module
	Fault cannot be isolated/repaired at the repair specialist level	Return the hand-held radio to depot for repair
Hand-held radio receives and/or transmits; however range is severely reduced	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the hand-held radio chassis to depot for repair
Hand-held radio will not function in the secure mode	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot for repair
Operating mode switch does not change the COMSEC mode	Failed hand-held radio chassis	Replace hand-held radio chassis
	Bad operating mode switch	Return the receiver-transmitter to depot for repair
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot for repair

Table 6-3. Organizational Maintenance Guide - Repair Specialist - CONT

Symptom	Possible Cause	Remedy
Volume switch does not change the volume	Failed transceiver module	Replace transceiver module
	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot for repair
Receiver-transmitter alarms in clear mode and does not transmit	Failed transceiver module	Replace transceiver module
	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot level for repair
Receiver-transmitter transmits OK, but with low transmit audio	Failed transceiver module	Replace transceiver module
	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot level for repair
Squelch switch does not function	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot level for repair
Hand-held radio does not accept programming data from the frequency fill device, the base station, or via cloning	Failed hand-held radio chassis	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot level for repair
Radio malfunction/error alarm	Failed transceiver module	Replace transceiver module
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot level for repair
Low battery warning	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot level for repair
TX time-out impending	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot level for repair
Crypto alarm	Failed hand-held radio chassis (crypto CCA)	Replace hand-held radio chassis
	Fault cannot be isolated/repaired at the repair specialist level	Return the system to depot level for repair
Unable to power radio through side connector (radio does not function when installed in vehicle adapter.)	Defective hand-held radio chassis	Return the hand-held radio chassis to repair specialist for repair

Table 6-4. Cross-Reference to Removal/Replacement Procedures

Item to be Removed/Replaced	Applicable Procedure(Paragraph Number)
Antenna	6-5.1.2
Audio Accessory	6-5.1.1
Battery	6-5.1.3
Control Knobs	6-5.2.2
Hand-Held Radio Chassis	6-5.2.1
Transceiver Module	6-5.1.4

6-5 REMOVAL/REPLACEMENT PROCEDURES.

6-5.1 Removal/Replacement Procedures - Operator.

(See Figure 7-2.) The first step for any remove/replace procedure is to power down the equipment. Prior to removing or installing any receiver-transmitter assembly, remove all accessories (antenna, microphone, etc.). Removal/replacement procedures that are authorized to be performed by the operator are given in paragraphs 6-5.1.1 through 6-5.1.4.

CAUTION

Use care in removing and replacing modules and CCAs to prevent damage to pins and sockets.

CAUTION

The modules and CCAs in the receiver-transmitter contain parts that are sensitive to damage by electrostatic discharge (ESD). Use ESD precautionary procedures (such as wearing grounding wrist straps) when touching, removing, and installing the module.

CAUTION

Before performing removal/replacement procedures, make sure the hand-held radio is powered down and the battery is removed from the hand-held radio. Failure to do so could result in equipment damage.

6-5.1.1 Audio Accessory Removal/Replacement

Remove/replace the audio accessory as follows:

a. Disconnect the audio accessory (e.g., palm handset), from the audio accessory connector (2, Figure 4-3) on the top of the receiver-transmitter by grasping the connector plug, pressing down, and twisting the plug one-quarter turn counterclockwise. (Refer to Figure 4-3 for connector diagram).

b. Replace the audio accessory with a known good one.

6-5.1.2 Antenna Removal/Replacement.

Remove/replace antenna as follows:

a. Disconnect the antenna from the antenna connector (3, Figure 4-3) at the top of the receiver-transmitter by grasping the antenna at the base, turning counterclockwise until unthreaded and pulling the antenna from the connector.

b. Replace the antenna with a known good antenna. Turn antenna clockwise to thread it into position.

6-5.1.3 Battery Removal/Replacement.

Remove/replace battery as follows:

CAUTION

Turn off power before removing the battery by setting the volume switch to the OFF position. Failure to do so can result in damage to the receiver-transmitter.

a. Disconnect the battery from the receiver-transmitter by sliding the battery latch (1, Figure 4-2) up toward the PTT switch, grasping the battery on the bottom of the receiver-transmitter, and turning the battery one quarter turn counterclockwise to unlock it from its position. Refer to Figures 2-2 and 4-2.

b. Replace the removed battery with a known good battery. Connect the battery to the receiver-transmitter by placing the battery perpendicular to the bottom of the receiver-transmitter, and turning the battery clockwise to lock it in position. Refer to Figure 2-2.

6-5.1.4 Transceiver Module Removal/Replacement

Remove/replace transceiver module as follows:

NOTE

The operator is authorized to remove/replace the transceiver module only when a repair specialist is not assigned to the deployed location or for emergency operational purposes. The determination of operational procedures must be made by local authority.

a. Loosen the eight captive Phillips screws that secure the transceiver module (1, 2, or 3, Figure 7-2) to the chassis.

b. Gently pry the transceiver module from the hand-held radio chassis (4) using a thin, flat-tipped screwdriver.

c. Replace the transceiver module with a known good transceiver module.

(1) Carefully seat the transceiver module onto the hand-held radio chassis, ensuring that the internal connectors line up with their associated receptacle.

(2) Tighten the eight captive Phillips screws. When refitting the transceiver module, inspect the electromagnetic interference (EMI) gasket (fixed to the cover and module) to ensure it is undamaged. Damaged/worn gasket can only be replaced at depot.

6-5.2 Removal/Replacement Procedures - Repair Specialist.

The following procedures are authorized to be performed by the repair specialist only, and are not available to the operator. Prior to performing any remove/replace procedure, ensure that the receiver-transmitter is powered down and the battery disconnected.

NOTE

When replacing the transceiver or hand-held radio chassis, verify programming information using either the frequency fill device or base station prior to verifying failure correction. Reload the crypto key, if applicable.

CAUTION

ELECTROSTATIC DISCHARGE

The receiver-transmitter contains components that are susceptible to damage by static electrical charges. Disassembly of the receiver-transmitter should only be done at a properly grounded work station.

CAUTION

Before performing removal/replacement procedures, make sure the hand-held radio is powered down and the battery is removed. Failure to do so could result in equipment damage.

NOTE

The hand-held radio chassis contains the crypto CCA and control CCA, which are authorized for repair only at depot. Any repair beyond separating the transceiver module and hand-held radio chassis would expose the crypto CCA and is not authorized except by COMSEC-briefed technician in a controlled (depot) environment.

6-5.2.1 Hand-Held Radio Chassis Removal/Replacement

Remove/replace hand-held radio chassis as follows:

NOTE
CONTROLLED CRYPTOGRAPHIC ITEM

The hand-held radio chassis is a controlled cryptographic item (CCI). It is authorized to be opened only by depot level maintenance.

a. Remove the transceiver module (1, 2, or 3, Figure 7-2) by loosening the eight captive Phillips screws that secure the module to the hand-held radio chassis.

b. Gently pry the transceiver module from the hand-held radio chassis using a thin, flat tipped screwdriver.

c. Replace the hand-held radio chassis (4) with a known good hand-held radio chassis.

(1) Carefully seat the transceiver module onto the hand-held radio chassis, ensuring that the internal connectors line up with their associated receptacle.

(2) Tighten the eight captive Phillips screws. When refitting the transceiver module, check the EMI gasket (fixed to the cover and module) to ensure it is undamaged. If damaged, return the hand-held radio chassis assembly to depot.

6-5.2.2 Control Knob Removal/Replacement.

Remove/replace control knobs as follows:

a. Remove the setscrew (using a .05"/1.27mm hex bit allen wrench) from the control knob to be removed.

b. Replace the control knob on the shaft and tighten the setscrew.

CHAPTER 7 ILLUSTRATED PARTS BREAKDOWN

Section I. INTRODUCTION

7-1 GENERAL

The illustrated parts breakdown (IPB) lists, illustrates, and describes the parts used in the Scope Shield Radio Set AN/PRC-139 (C) and the Programming Unit, Frequency, Radio MX-11531/U. The items are manufactured by Racal Communications Inc., Rockville, Maryland.

7-2 MAINTENANCE PARTS LIST.

The Maintenance Parts List (MPL), (Section II), consists of the complete systems divided into main groups. The main groups are broken down into assemblies, subassemblies, and details. The next higher assembly (NHA) is indicated for each separately illustrated item. Each assembly and subassembly listed is followed immediately by its component parts. In general, the assemblies and parts installed at the time the end item was manufactured are listed and identified in the manual. When an assembly/part (including vendor items) different from the original was installed during manufacture of the later items, series, or blocks, all assemblies and parts are listed (and "Usable on" coded). However, when the original assembly or part does not have continued application, only the preferred assembly or part is listed. When an assembly/part installed during modification, and the original does not have continued application, only the preferred item is listed. Interchangeable and substitute assemblies and parts, subsequently authorized by the Government, are not listed in this manual. When a standard size part can be replaced with an oversize/undersize part, the latter parts, showing sizes, are also listed.

a. Figure and Index Number Column. This column lists the figure and index number of each part illustrated in the related figure. The index numbers are in numerical sequence and indicate order of disassembly except where the order does not apply. Index numbers identify each part number shown in the related figure. Assemblies which have detail parts indexed are not indexed unless; the assembly is illustrated completely assembled on the same illustration; or it is identified as an assembly by bracketing or circling of components. When a group of parts (bolt, washer, nut) is used at a specific location for attachment purposes, one index number assigned is sufficient. The index number appears on the same line as the first part composing the group.

b. Part Number Column. This column lists the contractor's part number (drawing number), including dash numbers, assigned to each part. Vendor part numbers are listed when parts are identical to the contractor used part. Those parts which have Government Standards numbers assigned have the Government Standards number listed. Parts altered or selected for special fit, tolerance, etc., from vendor, commercial, or Government Standards part number of the altered or selected part follow the part description in the Description column. Item(s) of supply part number(s) and Contractor and Government Entity (CAGE) that is stocked, stored, and issued by the Government as identified by the Government during the initial provisioning process shall be identified by an (*) sign preceding the part number one space to the left. Government Furnished Equipment (GFE) and Contractor Furnished Equipment (CFE), covered by separate manuals are listed and identified by a number sign (#) inserted flush right following the part number. Decalcomania, metal-cals, and vinyl film markings are considered as parts. The part number for each marking will be followed by a asterisk (*) symbol inserted flush right. Requisition the marking in accordance with the requirements of AFR 6-1.

c. CAGE Column. This column contains a five-digit code number following the part number denoting the procuring vendor. The source of vendor code numbers is the CAGE for Manufacturer Cataloging Handbook H4-1, H4-2, and H4-3. When a CAGE for the appropriate manufacturer or Government agency is not published in the current issues of the H4 handbook, the word "none" will appear in this column.

d. Description Column. This column contains the description of all items appearing on the MPL. The indentation headed "1" through "7" consists of the approved item name, as found in the Federal Item Identification Guide for Supply Catalog Handbook H6-1, or is in accordance with the contractor's drawing title. The description contains modifiers necessary to identify the particular item. Additional information following the item description may include the following: a list of alternate part numbers to give stock ordering information; exceptions to the Usable On Code for the item; and references to preceding and subsequent figures concerning assemblies and subassemblies. This data is considered an integral part of the item description assuring the correctness of repair maintenance procedures.

e. Attaching Parts. Items used to attach parts or assemblies to each other are listed immediately after the part. The attaching parts have the same indentation code as the parts attached. The code (AP) appears on the same line with and immediately following the attaching part item.

f. Units Per Assembly. This column contains the number of units required per assembly and/or subassembly. If more than one assembly is required, the total number of assemblies is listed. When an assembly or subassembly is listed more than once, the total number of units per assembly or subassembly appears the first time and REF for subsequent listings.

g. Usable on Code Column. This column shows the Usable On Codes for systems, assemblies, and parts indicating specific usability by part number. Usable on code explanations are located at the bottom of the applicable page. The codes A, B, C, etc., when shown within a group, relate the part back to the same coded part within the next higher assembly. When this column is left bank, an assembly or part is common to all part number variation of the next higher assembly.

h. Source, Maintenance, and Recoverability (SMR) Codes. This manual contains Joint Military Services Uniform SMR codes. Detailed coding criteria may be obtained from T.O. 00-25-195.

7-3 NUMERICAL INDEX.

The Numerical Index (Chapter 7, Section III) is compiled in accordance with the numerical part number filing system described in paragraph a.

a. Part Number Column. This column contains all the part numbers that appear in the Maintenance Parts List and part numbers that have been assigned to detail parts assembled into the end article. The order of procedure establishing the precedence in which the part numbers are listed is explained below. The order of precedence in the first position of each part number is Letters A through Z, Numerals 0 through 9.

NOTE

Alphabetical O's are considered as numerical zeroes in all positions in each part number.

The order of precedence in the second and succeeding positions in each part number is as follows:

(1) Space (blank column).
(2) Diagonal (/).
(3) Period (.).
(4) Dash (-).
(5) Letters A through Z.
(6) Numerals 0 through 9.

The following is a sample of part numbers arranged in alphabetical-numerical sequence used in the Numerical Index.

AN931-4-13	B2	16.W2
A2460	S/1	16W060
A317	1140	32P010.1
A32	121873	32P0101
B12	128	39A45

b. Figure and Index Number Column. For each part number, the figure or figure and index number refers to the MPL where the parts relationship is shown. When an assembly or part has not been assigned an index number, the figure and index number of the preceding part in the MPL is used with the letter "F" before the figure, such as F7-7. The letter "F" denotes "follows".

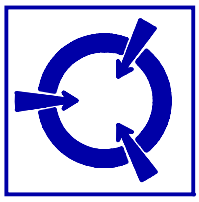
7-4 REFERENCE DESIGNATION INDEX.

The Reference Designation Index (Chapter 7, Section IV) is listed by figure as it appears in the MPL, then in alphabetical-numerical order, the reference designations used in schematic diagrams and instruction books. Opposite the reference designation is listed the figure index number as shown in the MPL.

7-5 ELECTROSTATIC DISCHARGE (ESD) SENSITIVE DEVICES.

a. This technical order contains parts and assemblies sensitive to damage by ESD. T.O. 00-25-234 should be consulted for specific information on how damage can occur to electronic parts, assemblies, and equipment by ESD and the control measures to be taken to protect against such damage.

b. Illustrations contained within this manual which depict ESD parts are further identified by the use of the following symbol affixed in the lower right-hand corner of each applicable illustration.

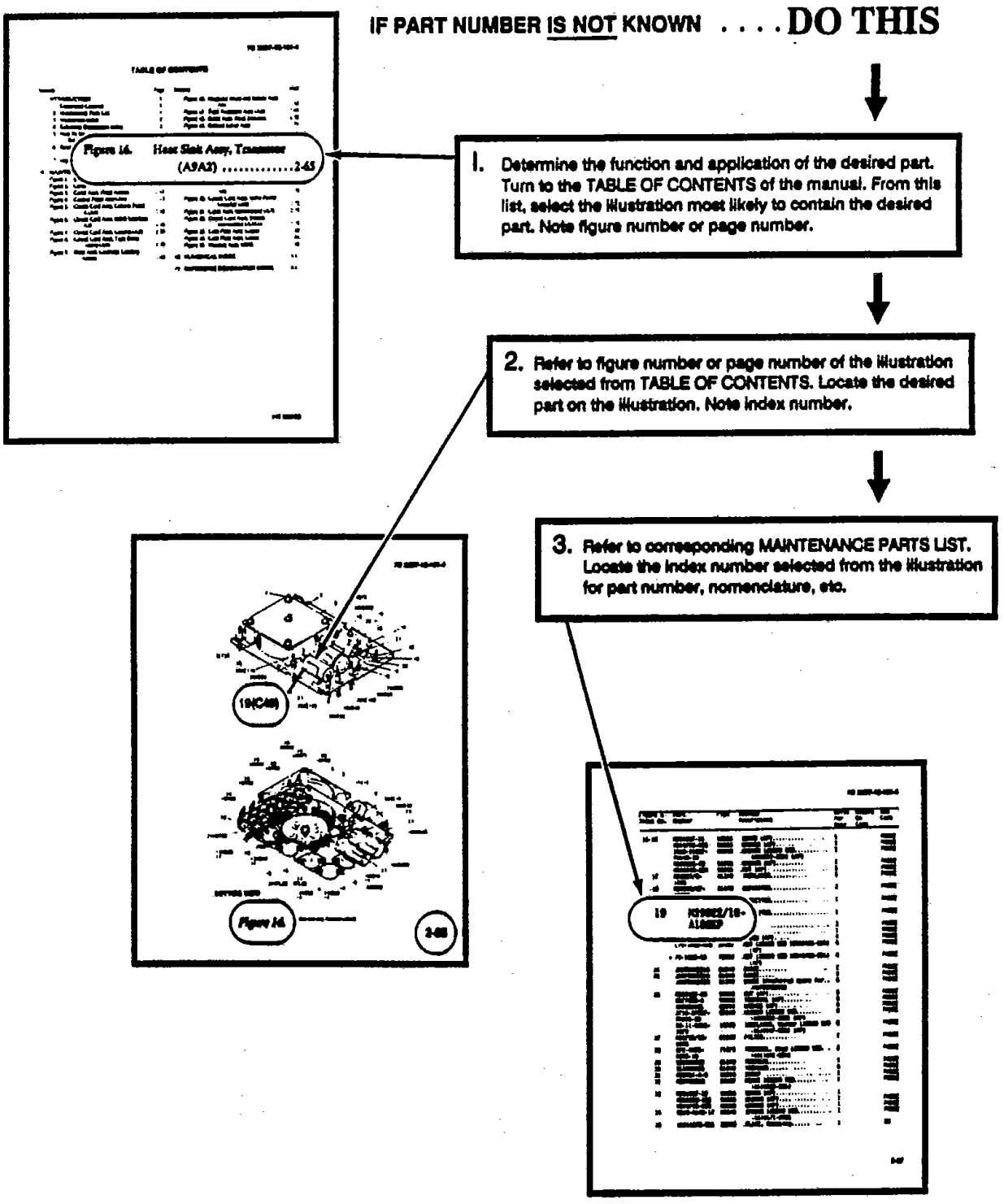


c. The MPL contained within this manual with ESD sensitive parts are identified by the following symbol (ESD). These symbols are placed in the extreme right of the description column for the item as ESD sensitive.

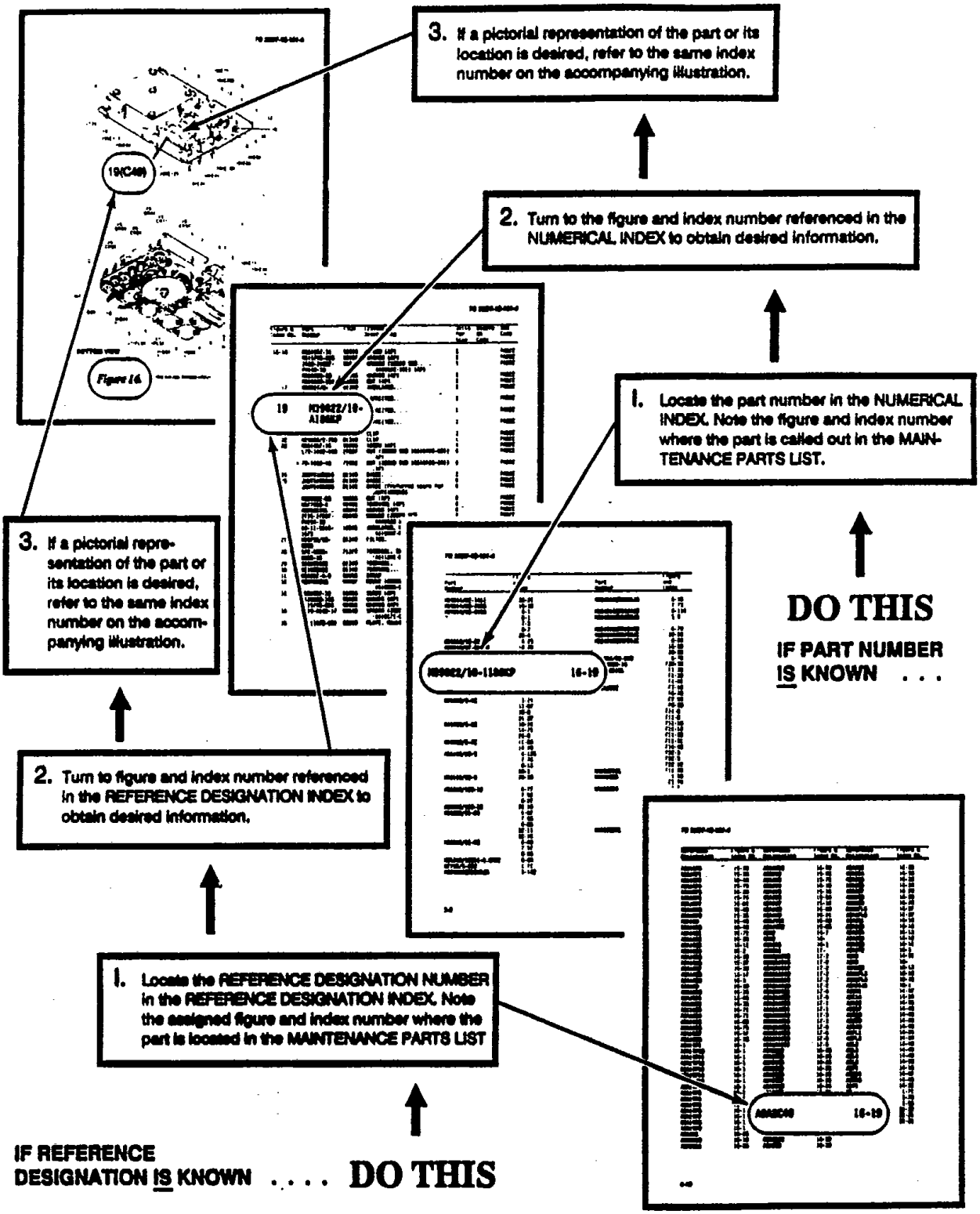
7-6 CAGE CODE SUMMARY.

CAGE Code	Manufacturer
05972	Locktite Corp.
23386	Racal Communications, Inc.
28856	Telex Communications Inc.
39428	McMaster-Carr Supply Co.
51828	Bren-Tronics Inc.
65451	Centurion INSTL Inc.
79184	Dow Corning
82820	Reif, M. M. and Co. Inc.
96906	Military Standards
K1057	Racal Acoustics Ltd.
K3834	Racal Antennas Ltd.
K8916	Holsters International Ltd.

HOW TO USE THE ILLUSTRATED PARTS BREAKDOWN


IF PART NUMBER IS NOT KNOWN . . . . DO THIS
1. Determine the function and application of the desired part. Turn to the TABLE OF CONTENTS of the manual. From this list, select the illustration most likely to contain the desired part. Note figure number or page number.
2. Refer to figure number or page number of the illustration selected from TABLE OF CONTENTS. Locate the desired part on the illustration. Note index number.
3. Refer to corresponding MAINTENANCE PARTS LIST. Locate the index number selected from the illustration for part number, nomenclature, etc.

HOW TO USE THE ILLUSTRATED PARTS BREAKDOWN


3. If a pictorial representation of the part or its location is desired, refer to the same index number on the accompanying illustration.
2. Turn to the figure and index number referenced in the NUMERICAL INDEX to obtain desired information.
1. Locate the part number in the NUMERICAL INDEX. Note the figure and index number where the part is called out in the MAINTENANCE PARTS LIST.
DO THIS
IF PART NUMBER IS KNOWN . . .
3. If a pictorial representation of the part or its location is desired, refer to the same index number on the accompanying illustration.
2. Turn to figure and index number referenced in the REFERENCE DESIGNATION INDEX to obtain desired information.
1. Locate the REFERENCE DESIGNATION NUMBER in the REFERENCE DESIGNATION INDEX. Note the assigned figure and index number where the part is located in the MAINTENANCE PARTS LIST
IF REFERENCE DESIGNATION IS KNOWN . . . . DO THIS

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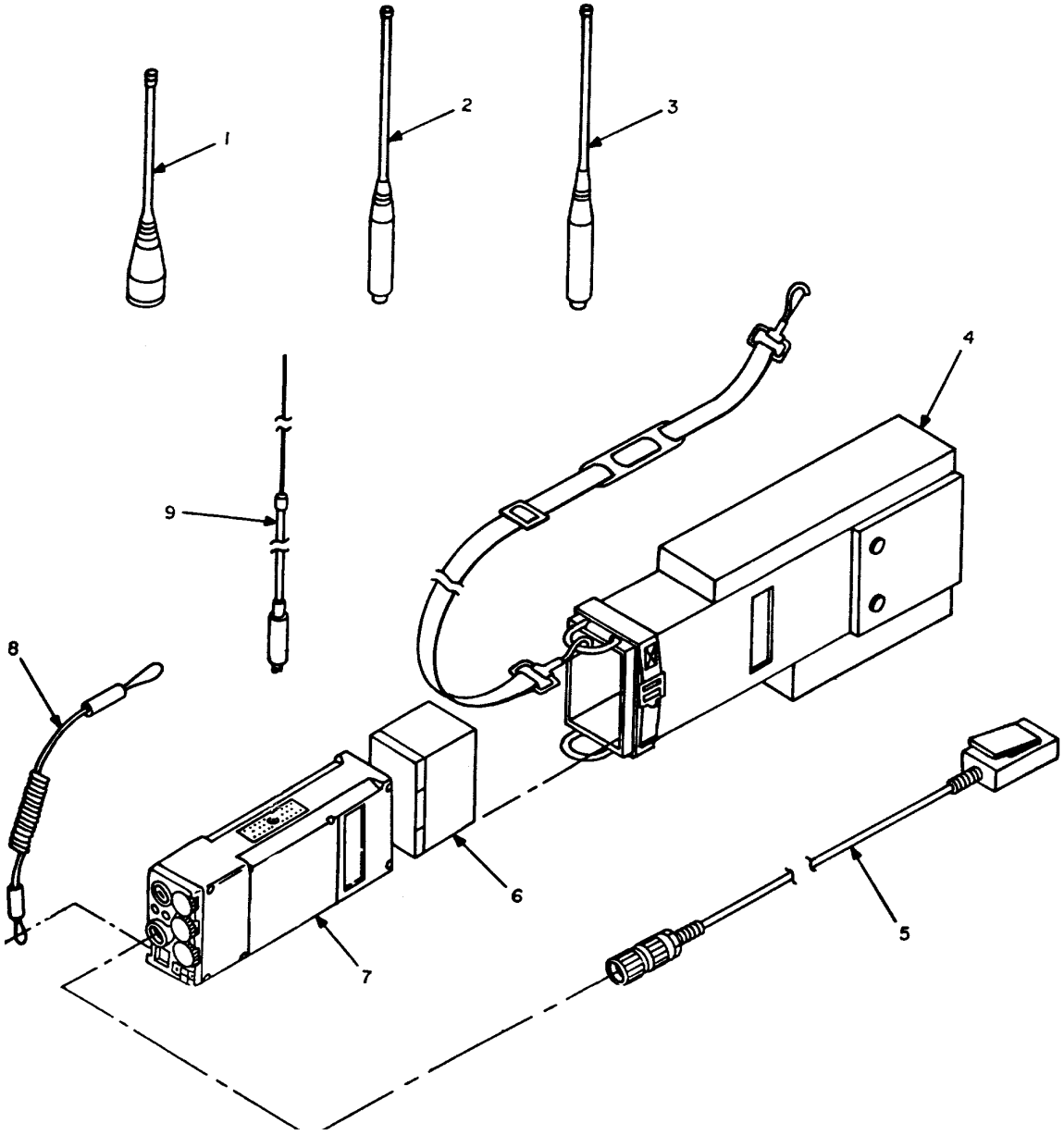


Figure 7-1. Radio Set AN/PRC-139 (C)

Section II. MAINTENANCE PARTS LIST

Table 7-1. Radio Set AN/PRC-139 (C)

Figure & Index No.	Part Number	CAGE	Description 1 2 3 4 5 6 7	Units per Assy	Usable on Code	SMR Code
7-1	SS-4100795-502	23386	Radio Set AN/PRC-139(C)	0001		PEODDS
7-1-1	CAF26165	65451	• Antenna, 403-470 MHz..... (23386/SS-1600294-1) (SPEC CTRL DRW)	0001		PAOZZN
7-1-2	CAF26307	65451	• Antenna, 136-174 MHz..... (23386/SS-1600293-1) (SPEC CTRL DRW)	0001		PAOZZN
7-1-3	CAF25422	65451	• Antenna, Short, 30-88 MHz ..... (23386/SS-1600291-1) (SPEC CTRL DRW)	0001		PAOZZN
7-1-4	CF-3152RC	82820	• Carrying Case, Camouflage ..... (23386/SS-1600245-1) (SPEC CTRL DRW)	0001		PAOZZN
7-1-5	SS-1600289-1	K1057	• Handset, Palm (Speaker)..... (23386/SS-1600289-1) (SPEC CTRL DRW)	0001		PAOZZN
7-1-6	BT70238	51828	• Battery, Rechargeable ..... (23386/SS-1600350-1) (SPEC CTRL DRW)	0001		PAOZZN
7-1-7	SS-4100807-502	23386	• Receiver-Transmitter RT-1696/U(C)..... (see Figure 7-2 for breakdown)	0001		PAODDT
7-1-8	SS-1600240-1	23386	• Lanyard ..... (23386/SS-1600240-1) (SPEC CTRL DRW)	0001		PAOZZN
7-1-9	SS-2100334-501	K3834	• Antenna Assy, 1 Meter..... (23386/SS-2100334-501) (SPEC CTRL DRW)	0001		PAOZZN

Figure 7-2. Radio Receiver-Transmitter Set RT-1696/U(C)

Table 7-2. Radio Receiver-Transmitter Set RT-1696/U(C)

Figure & Index No.	Part Number	CAGE	Description 1 2 3 4 5 6 7	Units per Assy	Usable on Code	SMR Code
7-2	SS-4100807-502	23386	Receiver-Transmitter (ESD)	0001		PAODDT
7-2-1	SS-4100820-501	23386	• Module, XCVR, RF 30-88 MHz (ESD).. (see TO 31R2-2PRC139-3 for breakdown)	0001		PAOLDT
7-2-1a	SS-2400541-1	23386	• • Screw Captive (AP).....	0008		PADZZN
7-2-1b	SS-2400543-1	23386	• • Washer, Crinkle, Special (AP)	0008		PADZZN
7-2-2	SS-4100821-501	23386	• Module, XCVR, RF 136-174 MHz (ESD) ..... (see TO 31R2-2PRC139-3 for breakdown)	0001		PAOLDT
7-2-3	SS-4100822-501	23386	• Module, XCVR, RF 403-470 MHz (ESD) ..... (see TO 31R2-2PRC139-3 for breakdown)	0001		PAOLDT
7-2-4	SS-4100819-501	23386	• HHR Chassis ..... (see TO 31R2-2PRC139-3 for breakdown)	0001		PAOLDT
7-2-5	MS21318-1	96906	• Screw, Drive ..... (23386/76893) (SPEC CTRL DRW)	0001		PAOZZN
7-2-6	SS-2400522-1	23386	• Identification Plate, HHR.....	0001		XB
7-2-7	92383A154	39428	• Pin, Spring ..... (23386/SS-81380) (SPEC CTRL DRW)	0001		PAOZZN
7-2-8	SS-2400607-1	23386	• Plate, Chip.....	0001		XB

Figure 7-3. Programmer Unit, Frequency, Radio MX-11531/U

Table 7-3. Programmer Unit, Frequency, Radio MX-11531/U

Figure & Index No.	Part Number	CAGE	Description 1 2 3 4 5 6 7	Units per Assy	Usable on Code	SMR Code
7-3	MX-11531/U	23386	Receiver-Transmitter (ESD)	0001		XB
7-3-1	SS-4100797-501	23386	• Frequency Fill Device (ESD)..... (see TO 31R2-2PRC139-3 for breakdown)	0001		PAOLDT
7-3-2	SS-3500276-501	23386	• • Programming Cable	0001		PAOZZN
7-3-3	SS-3500280-501	23386	• Cable Assembly, Crypto (ESD)	0001		PAOZZN

Section III. NUMERICAL INDEX

Part Number	Figure & Item Number	Part Number	Figure & Item Number	Part Number	Figure & Item Number
92383A154	7-2-7	SS-2400607-1	7-2-8		
BT70238	7-1-6	SS-3500276-501	7-3-2		
CAF25422	7-1-3	SS-3500280-501	7-3-3		
CAF26165	7-1-1	SS-4100795-501	7-1		
CAF26307	7-1-2	SS-4100797-501	7-3-1		
CF-3152RC	7-1-4	SS-4100807-502	7-1-7		
MS21318-1	7-2-5	SS-4100807-502	7-2		
MX-11531/U	7-3	SS-4100819-501	7-2-4		
SS-1600240-1	7-1-8	SS-4100820-501	7-2-1		
SS-1600289-1	7-1-5	SS-4100821-501	7-2-2		
SS-2100334-501	7-1-9	SS-4100822-501	7-2-3		
SS-2400522-1	7-2-6				
SS-2400541-1	7-2-1a				
SS-2400543-1	7-2-1b				

Section IV. REFERENCE DESIGNATION INDEX

This section is not applicable

Section V. COMMON BULK ITEMS LIST

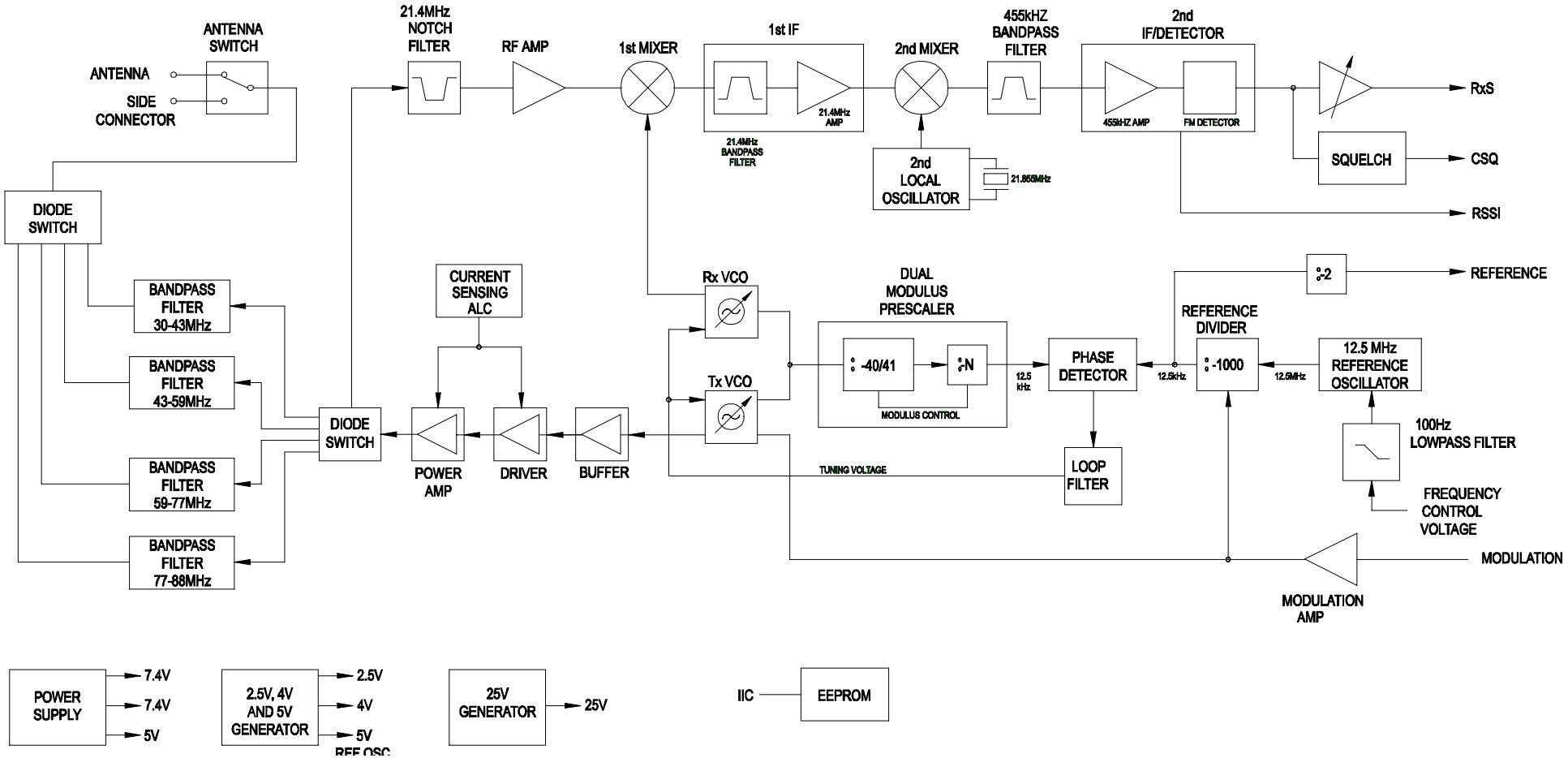
Part Number	CAGE Code	Description	Unit of Measure
738 3oz	79184	Adhesive/Sealant RTV (23386/91099)	A/R
No 222 50CC	05972	Threadlocking Compound No. 222 (23386/91137)	A/R

CHAPTER 8. CIRCUIT DIAGRAMS

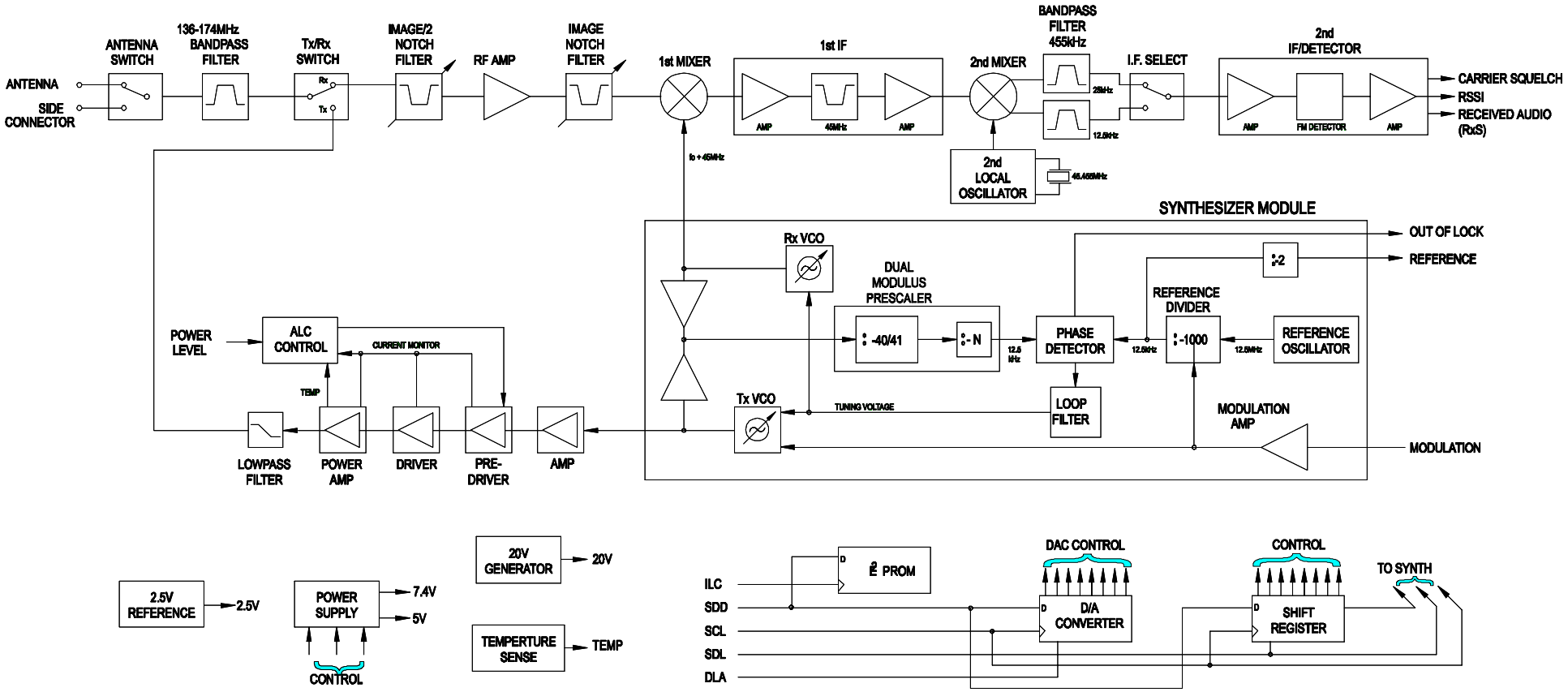
8-1 SCOPE.

This chapter contains the following illustrations:

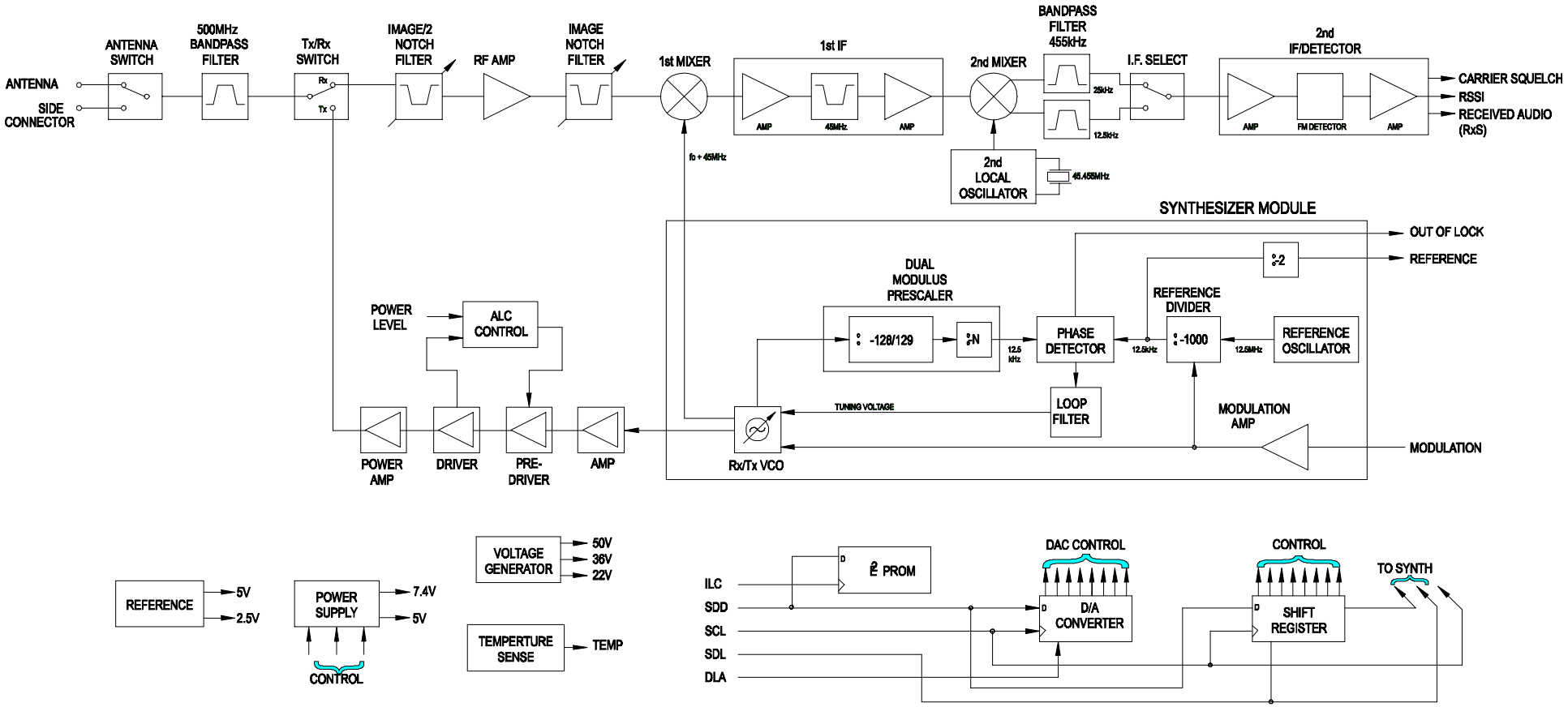
Figure No.	Title
FO-1	Tactical Band (30-88 MHz), Functional Block Diagram
FO-2	High Band (136-174 MHz), Functional Block Diagram
FO-3	Ultra High Band (403-470 MHz), Functional Block Diagram
FO-4	Control CCA, Interconnection Diagram
FO-5	Crypto CCA, Interconnection Diagram
FO-6	Interconnection Diagram, AN\PRC-139 (C)



FO-1. Tactical Band (30-88 MHz),
Functional Block Diagram



FO-2. High Band (136-174 MHz),
Functional Block Diagram



FO-3. Ultra High Band (403-470 MHz), Functional Block Diagram

FO-4. Control CCA,
Interconnection Block Diagram

FO-5. Crypto CCA,
Interconnection Block Diagram

FO-6. AN\PRC-139 (C),
Interconnection Diagram

GLOSSARY

AC	Alternating current
AH	Ampere-hour
ALC	Automatic level control
AP	Attaching parts
ASSY	Assembly
BW	Bandwidth
C	Celsius (centigrade)
CCA	Circuit card assembly
CCI	Controlled cryptographic item
CLK	Clock
CLR	Clear
cm	Centimeter
COMSEC	Communications Security
CTCSS	Continuous tone-controlled squelch systems
CTRL	Control
CVSD	Continuous variable slope delta
CW	Continuous wave
DAC	Digital-to-analog converter
dB	Decibel
DC	Direct current
DRW	Drawing
EMI	Electromagnetic interference
ESD	Electrostatic discharge
ESDS	Electrostatic discharge sensitive
F	Fahrenheit
FM	Frequency Modulation (modulated)
FREQ	Frequency
HF	High frequency
HHR	Hand held radio
Hz	Hertz
IF	Intermediate frequency
in.	Inch
kbps	Kilobits/second
KEK	Key encryption key
KEY	Cryptographic encryption key
kg	Kilograms
kHz	Kilohertz
lbs	Pounds
LED	Light emitting diode
LO	Local oscillator
mA	Milliampere
MHz	Megahertz
MPL	Maintenance parts lists
ms	Milliseconds
N/C	No connection
NiCad	Nickel cadmium
PA	Power amplifier
PTT	Push-to-talk
PWM	Pulse width modulated
PWR	Power
RF	Radio frequency
RSSI	Received signal strength indicator
RT	Receiver-transmitter
RX	Receive
SARK	Saville advanced remote keying

SINAD	Ratio of signal to noise distortion/noise + distortion
SMR	Source, Maintenance, and Recoverability Code
SPEC	Specification
TEK	Traffic encryption keys
TX	Transmit
UHF	Ultra high frequency
V	Volt
VAC	Volts alternating current
VCO	Voltage controlled oscillator
VHF	Very high frequency
W	Watt
WB	Wideband
XCVR	Transceiver
Z	Zeroize

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APPENDIX A

OPERATION AND MAINTENANCE INSTRUCTIONS

ORGANIZATIONAL LEVEL

PROGRAMMER UNIT, FREQUENCY, RADIO MX-11531/U

(FREQUENCY FILL DEVICE)

CHAPTER A1 OPERATION

Section I. CONTROLS AND INDICATORS

A1-1 CONTROLS AND INDICATORS.

All operator controls and indicators of Programmer Unit, Frequency, Radio MX-11531/U (hereinafter referred to as the frequency fill device) are described in Table A1-1 and illustrated in Figure A1-1.

Table A1-1. Description of Controls and Indicators

Fig & Index Number	Control/Indicator	Function
A1-1-1	Display (16-character by 2-line dot matrix LCD backlit display)	Displays a sequence of menus and prompts during programming of the receiver-transmitter.
A1-1-2	0-9 numeric entry keys	Allows entry of frequency and channel data.
A1-1-3	ENTR key	Data entry and menu select/execute key. No operations to/from a receiver-transmitter will be performed until the ENTR key is depressed.
A1-1-4	● LAMP	Decimal point for numeric entries and LAMP for toggling the LCD backlighting On/Off.
A1-1-5	↓	Decrement data, menu scroll down, contrast control.
A1-1-6	↑	Increment data, menu scroll up, contrast control.
A1-1-7	CLR key	Clears data entries and provides a return to previous menu levels.
A1-1-8	CHAN key	Channel select; places the number keys in the channel select mode. The new channel is selected by pressing the numbered keys and the ENTR key.

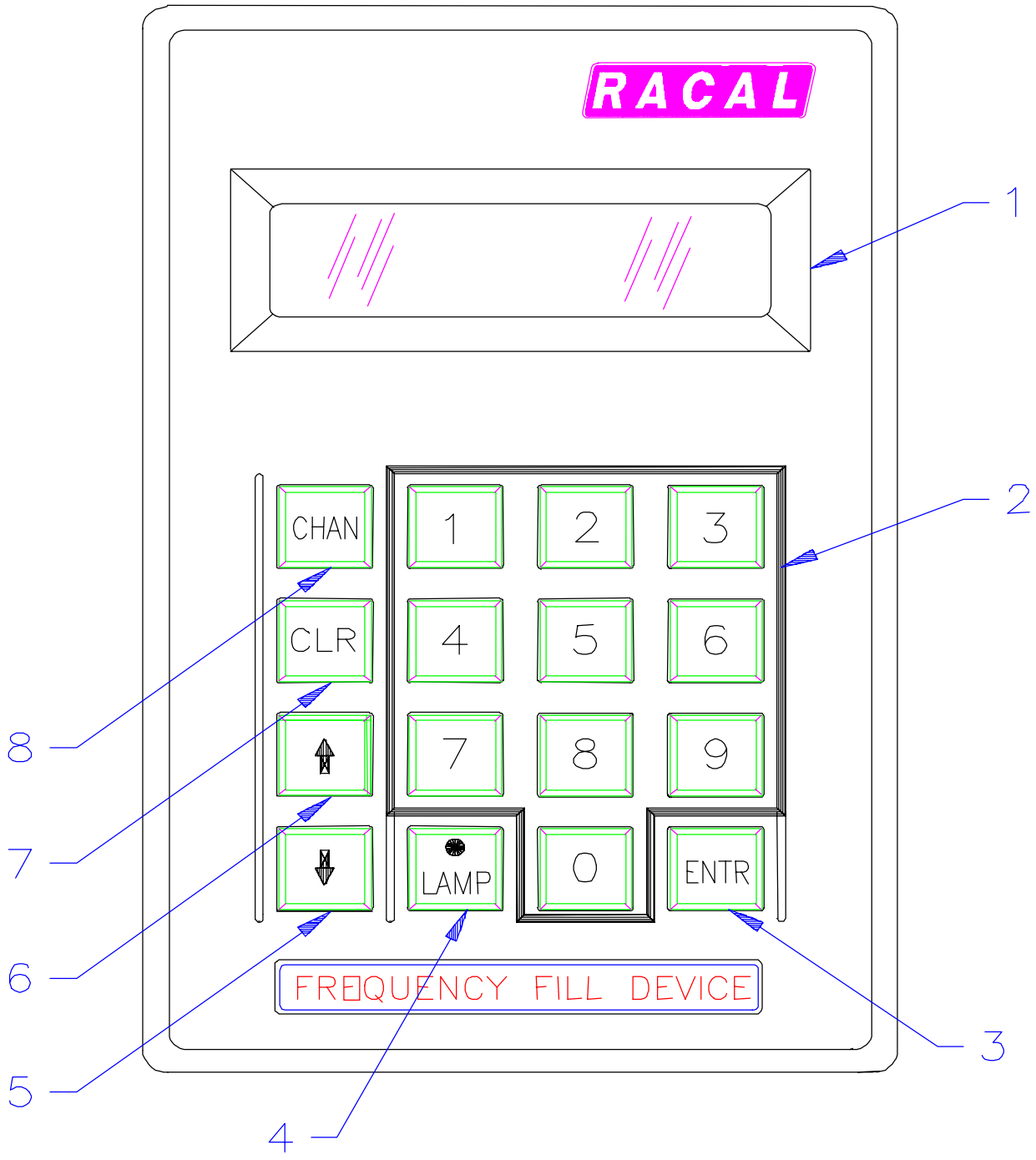


Figure A1-1. Display and Keys

Section II. OPERATING INSTRUCTIONS

A1-2 RECEIVER-TRANSMITTER (RT-1695/TRC-199 AND RT-1696/U(C)), PROGRAMMING INFORMATION.

A1-2.1 Introduction.

The frequency fill device can be used to program either the RT-1695/TRC-199 or the RT-1696/U(C) receiver-transmitters used on the AN/PRC-139(C), AN/GRC-238, or AN/TRC-199. Paragraphs A1-2.2 through A1-2.7 provide general receiver-transmitter programming instructions which should be reviewed before following the detailed receiver-transmitter programming instructions given in paragraph A1-3.

As entries are made on the frequency fill device keypad and the ENTR key is pressed, the selected receiver-transmitter parameters are changed within the connected receiver-transmitter. If an error is discovered in the entered data, the operator must re-enter the correct data. None of the receiver-transmitter data is saved within the frequency fill device after pressing the ENTR key. Any programming data that has been keyed in to the frequency fill device but not uploaded to the receiver-transmitter with the ENTR key will be lost if the frequency fill device is powered-down. When programming the receiver-transmitter with the frequency fill device, only those individual parameters which have been selected and entered will be changed on the receiver-transmitter. All other receiver-transmitter data will remain unchanged. A detailed description of programmable parameters is contained in Tables 4-5 and 4-6 of the main body of this TO.

A1-2.2 Receiver-Transmitter Global Operations.

There are some receiver-transmitter parameters that affect all receiver-transmitter channels equally. For example, the transmit (TX) timeout parameter is the same for all channels. These parameters are referred to as global parameters and are programmed via global menus.

Example: If the global parameter TX Timeout is set to 30 seconds, then all channels will have a 30 second transmit timeout.

Receiver-transmitter global parameters are the squelch level, TX timeout and clone control. The global menus also contain a selection called "PROGRAM CHANNEL ?" which, if selected, will transfer the menu control to the receiver-transmitter channel operations menus discussed in the next section. The TX Timeout feature automatically ends transmission after a fixed period of time. The purpose is to prevent inadvertent or prolonged operation in transmit mode that can significantly reduce battery life.

A1-2.3 Receiver-Transmitter Channel Operations.

All of the receiver-transmitter programmable parameters that are not global are considered to be channel parameters. In other words, channel 1 parameters may be programmed completely differently and independently from those for channel 2 and so on. For example, the channel 1 transmit frequency may be set to 136.0125 MHz while the channel 2 transmit frequency may be set to 172.0250 MHz. Channel parameters are the receive (RX) frequency, TX frequency, RX CTCSS tone, TX CTCSS tone, RF transmit power, RX IF bandwidth, and secure data speed (12 or 16 kilobits per second (kbps)).

While in the channel functions menu, the frequency fill device will display the current receiver-transmitter channel selected in the upper right-hand corner of the frequency fill device display. Refer to paragraph A1-3.5.2 for a sample 2-line display window. The selected channel may be changed by simply pressing the CHAN key (8, Figure A1-1). The channel display will blank the current channel and display a flashing cursor. The data keys can then be used to key-in the desired channel followed by the ENTR key (3, Figure A1-1). The arrow keys (5, 6, Figure A1-1) can also be used to increment or decrement the channel number.

A1-2.4 Menu Operations.

The following paragraphs provide instruction to the user on the menu operations of the frequency fill device, including the purpose of the various menu types and movement from menu to menu. It cannot possibly cover all possible combinations of data entry. Therefore, only one example of each menu group is provided. It is assumed that the user is already knowledgeable on Radio Set AN/PRC-139(C) operation.

A1-2.4.1 Movement Between Menus.

The up arrow key (↑) will scroll up from the current menu or option and the down arrow (↓) key will scroll down from the current menu or option. The arrow keys will not scroll if there is only one selection currently available, as with the program radio. At this initial menu, the arrow keys will control the contrast of the LCD display. There are eight contrast levels available for adjustment.

All menus are circular; that is, they will always roll-over from end to beginning from a scroll-up or scroll-down operation. There are no write operations to the receiver-transmitter during scroll operations. However, during scrolling, the frequency fill device queries the receiver-transmitter on the displayed parametric, and displays the value currently programmed in the receiver-transmitter. For example, if transmit frequency for channel 1 is selected on the frequency fill device, the display will contain the channel 1 transmit frequency currently programmed in the receiver-transmitter. If channel 2 is then selected, the frequency fill device will check the channel 2 transmit frequency programmed in the receiver-transmitter and display that value. If no value is programmed, the display will read "TX FREQ=." A menu may consist of any combination of operations, options or menu selections. Figure A1-2 is a simplified diagram showing available menus.

A1-2.4.2 Movement Into/Out of Menus.

The ENTR key is used to advance into the menu structure, select menu options, and enter data keyed in with the data keys if required by a selected operation, such as frequency entries. The CLR key is used to back out of the menu structure, to deselect an operation within a menu or to delete non-valid entries keyed in with the data entry keys.

A1-2.5 Data Entry Operations.

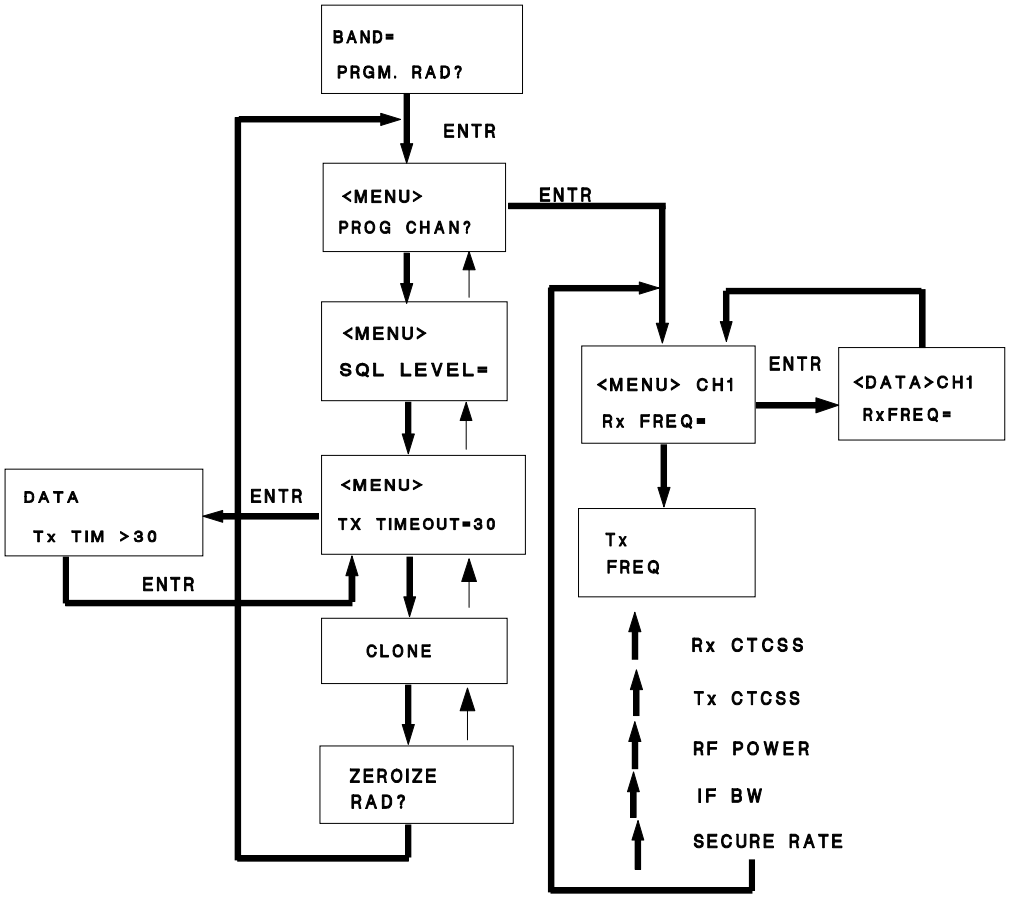
When the menu selection is a data entry operation, the first press of the ENTR key will activate the data entry window. The word <MENU> on the first line of the display will be displayed with <DATA>, and the existing data and = sign on the second line will disappear and a > sign will appear in the display, indicating that new data must be selected by using the ↑ and ↓ keys (or the numeric keys for frequency selection). The new data must be entered with an additional press of the ENTR key. The display will remain in the current menu selection with the new data and = sign displayed for verification and the data entry window disabled (<DATA> displayed with <MENU>).

A1-2.6 Channel and Frequency Data Entries.

With frequency and channel entries, if an erroneous value has been keyed in and the ENTR key pressed, the frequency fill device returns to the start of the frequency or channel entry mode re-blinking the right most display field character. If erroneous digits are entered into the display field, the CLR key (7, Figure A1-1) can be used to clear the display starting from the least significant digit until the error can be corrected. The maximum number of digits that can be entered in the frequency mode is eight, including a decimal point, and two digits in the channel mode. No decimal point entries are accepted in the channel mode. The CHAN key (8 Figure A1-1) is used to invoke the channel entry mode and valid channel entries are from channel 0 through channel 14. In both frequency and channel modes the ENTR key (3, Figure A1-1) must be pressed to download the new data into the receiver-transmitter. Channels may be changed at any time during a programming sequence.

A1-2.7 Zeroizing the Receiver-Transmitter.

The transmit and receive frequency information loaded into a receiver-transmitter may be zeroized using the frequency fill device. The zeroize function simply programs the receiver-transmitter TX and RX frequencies to zero for all channels and programs factory default values for the remaining parameters. Refer to Table 4-5 for the zeroized default values for each parameter. The COMSEC keys must be zeroized using the operating mode switch as described in paragraph 4-12.



GLOBAL : Center column accessed via UP/DOWN arrows.

CHANNEL SPECIFIC : ENTR from PROGRAM CHANNEL? to RX FREQ=

UP/DOWN arrows to access other channel parameters

Hit CLR at any of the channel specific menus to return to PROGRAM CHANNEL? screen.

Hit CLR at any of the global menus to return to PROGRAM RADIO? screen.

Figure A1-2. Available Menus

A1-3 DETAILED RECEIVER-TRANSMITTER PROGRAMMING INSTRUCTIONS.

A1-3.1 Introduction.

Paragraph A1-3.2 through A1-3.5 provide detailed instructions on programming a 136-174 MHz receiver-transmitter using the frequency fill device. The general operation of the frequency fill device is the same when programming a 30-88 MHz or 403-470 MHz receiver-transmitter (a 30-88 MHz receiver-transmitter cannot be programmed for IF bandwidth, as only 25.0 kHz is available).

For purposes of this example, assume that a receiver-transmitter is already programmed with the following CHANNEL 1 and global data:

RECEIVER-TRANSMITTER'S CURRENT PROGRAMMED DATA

CHANNEL	RX FREQ	TX FREQ	RX TONE	TX TONE	RF POWER	RX IF BW	SECURE RATE
1	136.0250	168.5000	167.9	114.8	2.0	25	16

GLOBAL DATA

Squelch Level = 12 dB
TX Timeout = 30 Seconds
Clone Control = SLAVE

The procedures on the following pages will discuss how to reprogram the receiver-transmitter with the following information:

Menu	New Data	Parameter Type
Squelch Level	14 dB	(Global)
TX Timeout	90 Seconds	(Global)
Clone Control	Master	(Global)
RX Frequency	168.5000 MHz	(for Channel 1)
TX Frequency	154.6125 MHz	(for Channel 1)
RX CTCSS Tone	114.8 Hz	(for Channel 1)
TX CTCSS Tone	NONE	(for Channel 1)
RF Transmit Power	0.5 Watts	(for Channel 1)
RX IF Bandwidth	12.5 kHz	(for Channel 1)
Secure Data Rate	12 kbps	(for Channel 1)

LIST OF ACRONYMS

RX FREQ- Receive Frequency
TX FREQ- Transmit Frequency
RX CTCSS- Receive Continuous Tone Controlled Squelch System
TX CTCSS- Transmit Continuous Tone Controlled Squelch System
BW- Bandwidth
PWR- Transmit Power in Watts

A1-3.2 Initial Power-up.

Power-up the frequency fill device as follows:

a. Ensure that the programming cable (P/N SS-3500276-501) provided with the frequency fill device is connected to the audio accessory connector on the receiver-transmitter. A battery must be connected to the receiver-transmitter.

b. Turn the receiver-transmitter power/volume switch (3, Figure 4-1) to mid-range position. Turn the receiver-transmitter channel select switch (4, Figure 4-1) to channel 1. Ensure that there are no warning tones. The frequency fill device will remain powered down at this time.

c. Press and release any key on the frequency fill device keypad. The frequency fill device will immediately execute a display segment test for approximately 1 second. At the completion of the test, the frequency fill device should display the initial configuration shown below.

NOTE

The initial configuration menu shown below assumes that the frequency fill device is connected to a 136-174 MHz receiver-transmitter.

```
BAND=136-174 MHz
PROGRAM RADIO ?
```

A1-3.3 Turning Display Lighting On/Off.

Use the LAMP key (4, Figure A1-1) on the keypad to turn on and off frequency fill device display backlighting.

A1-3.4 Setting Display Contrast Control.

Adjust the display contrast as follows:

a. Use the up arrow (↑) key (6, Figure A1-1) to incrementally increase display contrast.
b. Use the down arrow (↓) key (5, Figure A1-1) to incrementally decrease display contrast.

A1-3.5 Programming Channel.

Program the selected receiver-transmitter channel as described in the following paragraphs.

A1-3.5.1 Select Program Channel Option.

Select the program channel option as follows:

a. Press the ENTR key (3, Figure A1-1) at the "PROGRAM RADIO?" display to select the following menu on the 16-character display (1, Figure A1-1).

```
<MENU>
PROGRAM CHANNEL ?
```

b. Press the ENTR key again to select channel specific parameters, then use the up arrow (↑) key (6, Figure A1-1) and/or down arrow (↓) key (5, Figure A1-1) to scroll through the following menu options: RX FREQ, TX FREQ, RX TONE, TX TONE, RF POWER, RX IF BANDWIDTH and SECURE RATE. Each of these options are explained in the following paragraphs.

c. At the PROGRAM CHANNEL menu, use the arrow keys to scroll through the following global parameter menus: squelch LVL, TX timeout, clone, and zeroize receiver-transmitter. Each of these options is explained in paragraph A1-3.6.

A1-3.5.2 Select RX Frequency.

The receive frequency option will appear as follows after pressing the ENTR key at the "PROGRAM CHANNEL?" prompt:

```
<MENU>  CHAN 1
RX FREQ=136.0250
```

a. If the receive frequency is correct, press the (↑) arrow key to proceed to the next option.

b. If the receive frequency needs to be changed, press the ENTR key at this point. The data entry screen will appear as follows:

```
<DATA>  CHAN 1
RX FREQ>
```

NOTE

The = sign has been replaced with the > sign along with a flashing cursor, indicating the frequency entry mode.

c. To change the receive frequency to 168.5 MHz, for example, key in the new frequency using the numeric and decimal point keys, then press the ENTR key. The display will now look like this:

```
<MENU>  CHAN 1
RX FREQ=168.5000
```

NOTE

When the ENTR key is pressed, the frequency fill device transmits the new programming data to the receiver-transmitter. The new data is then read back from the receiver-transmitter and displayed.

d. The display will remain in the current menu selection with the new data and the = sign displayed for verification.

NOTE

The frequency fill device automatically reprograms the transmit frequency to the new receive frequency as well.

A1-3.5.3 Select TX Frequency.

After depressing the (↑) key, the transmit frequency option will appear as follows:

```
<MENU>  CHAN 1
TX FREQ=168.5000
```

a. If the transmit frequency is correct, press the (↑) arrow key to proceed to the next option.

b. If the transmit frequency needs to be changed, press the ENTR key at this point. The data entry screen will appear as follows:

```
<DATA>  CHAN 1
TX FREQ>
```

NOTE

The = sign has been replaced with the > sign along with a flashing cursor, indicating the frequency mode.

c. To change the transmit frequency to 154.6125 MHz, key in the new frequency using the numeric and decimal keys and then press the ENTR key. The display will now look like this:

```
<MENU>  CHAN 1
TX FREQ=154.6125
```

d. The display will remain in the current menu selection with the new data and the = sign displayed for verification.

NOTE

Only the transmit frequency is programmed; the receive frequency is unchanged.

A1-3.5.4 Select RX Tone.

After depressing the (↑) key, the receive tone option will appear as follows:

```
<MENU>  CHAN 1
RX TONE=167.9HZ
```

a. If the receive tone is correct, press the (↑) arrow key to proceed to the next option.

b. If the receive tone level needs to be changed, press the ENTR key at this point. The data entry screen will appear as follows:

```
<DATA>  CHAN 1
RX TONE>167.9 HZ
```

NOTE

The = sign has been replaced with the > sign, indicating the data entry mode.

c. To change the receive tone to 114.8 Hz, scroll through the values using the arrow keys until the desired frequency is displayed and then press ENTR. The display will look like this:

```
<MENU>  CHAN 1
RX TONE=114.8 HZ
```

d. The display will remain in the current menu selection with the new data and the = sign displayed for verification.

NOTE

The frequency fill device automatically reprograms the TX tone to the new RX tone as well.

A1-3.5.5 Select TX Tone.

After depressing the (↑) key, the transmit tone option will appear as follows:

```
<MENU>  CHAN 1
TX TONE=114.8HZ
```

a. If the displayed transmit tone is correct, press the (↑) arrow key to proceed to the next option.

b. If the transmit tone frequency needs to be changed, press the ENTR key at this point. The data entry screen will appear as follows:

```
<DATA>  CHAN 1
TX TONE>114.8HZ
```

NOTE

The = sign has been replaced with the > sign, indicating the data entry mode.

c. To change the transmit tone to NONE, scroll through the values using the arrow keys until NONE is displayed and then press ENTR. The display will look like this:

```
<MENU>  CHAN 1
TX TONE=NONE
```

d. The display will remain in the current menu selection with the new data and = sign displayed for verification.

NOTE

Only the transmit CTCSS tone is programmed; the receive CTCSS tone is unchanged.

A1-3.5.6 Select RF Power.

After depressing the (↑) key, the RF power option will appear as follows:

```
<MENU>  CHAN 1
RF POWER=2.0 W
```

a. If the RF power level is correct, press the (↑) arrow key to proceed to the next option.

b. If the RF power level needs to be changed, press the ENTR key at this point. The data entry screen will appear as follows:

```
<DATA>  CHAN 1
RF POWER>2.0W
```

NOTE

The = sign has been replaced with the > sign, indicating the data entry mode.

c. To change the RF power to 0.5 watt, press the (↑) or (↓) key and then press ENTR. The display will look like this:

```
<MENU>  CHAN 1
RF POWER=0.5 W
```

d. The display will remain in the current menu selection with the new data and the = sign displayed for verification.

A1-3.5.7 Select RX IF Bandwidth.

The RX IF bandwidth is programmable for 136-174 MHz and 403-470 MHz receiver-transmitters only. The bandwidth menu will not appear when programming a 30-88 MHz receiver-transmitter.

a. After pressing the (↑) key, the RX IF bandwidth menu will appear as follows:

```
<MENU>  CHAN 1
RX IF BW=25.0KHZ
```

b. If the RX IF bandwidth selection is correct, press the (↑) arrow key to proceed to the next menu.

c. If the RX IF bandwidth selection needs to be changed, press the ENTR key at this point. The data entry screen will appear as follows:

```
<DATA>  CHAN 1
RX IF BW>25.0KHZ
```

NOTE

The = sign has been replaced with the > sign, indicating the data entry mode.

d. To change the RX IF bandwidth to 12.5 kHz, press the (↑) or (↓) key and then press ENTR. The display will appear as below:

```
<MENU>  CHAN 1
RX IF BW=12.5KHZ
```

e. The display will remain in the current menu selection with the new data and the = sign displayed for verification.

A1-3.5.8 Select Secure Data Rate.

After pressing the (↑) key, the secure rate data menu will appear as follows:

```
<MENU>  CHAN 1
SECURE RATE=16KB
```

a. If the secure data rate is correct, press the (↑) key to proceed to the next option.

b. If the secure data rate needs to be changed, press the ENTR key at this point. The data entry screen will appear as follows:

```
<DATA>   CHAN 1
SECURE RATE>16KB
```

NOTE

The = sign has been replaced with the > sign indicating the data entry mode.

c. To change the secure data rate to 12 kbps, press the (↑) or (↓) key and then press ENTR. The display will look like this:

```
<MENU>   CHAN 1
SECURE RATE=12KB
```

d. The display will remain in the current menu selection with the new data and the = sign displayed for verification.

A1-3.6 Global Menu Options.

A1-3.6.1 Squelch LVL.

After depressing the (↑) key at the "PROGRAM CHANNEL ?" prompt, the squelch level option will appear as follows:

```
<MENU>
SQUELCH LVL=12DB
```

a. If the squelch level is correct, press the (↑) arrow key to proceed to the next menu.

b. If the squelch level needs to be changed, press the ENTR key. The data entry screen will appear as follows:

```
<DATA>
SQUELCH LVL>12DB
```

NOTE

The = sign has been replaced with the > sign, indicating the data entry mode.

c. To change the squelch level to 14 dB, scroll through the values using the arrow keys until the 14 dB is displayed and then press ENTR. The display will look like this:

```
<MENU>
SQUELCH LVL=14DB
```

d. The display will remain in the current menu selection with the new data and the = sign displayed for verification.

A1-3.6.2 TX Timeout.

After depressing the (↑) key, the TX timeout menu will look like this:

```
<MENU>
TX TIMEOUT= 30 S
```

a. If the TX timeout is correct, press the (↑) arrow key to proceed to the next menu.

b. If you wish to adjust the TX timeout, press the ENTR key. The menu will appear as follows:

```
<DATA>
TX TIMEOUT>30 S
```

NOTE

The = sign has been replaced with the > sign, indicating the data entry mode.

c. To change the timeout to 90 seconds, scroll through the values until the desired timeout is displayed and then press ENTR. The screen will look like this:

```
<MENU>
TX TIMEOUT= 90 S
```

d. The display will remain in the current menu selection with the new data and the = sign displayed for verification.

A1-3.6.3 Clone Control.

After depressing the (↑) key, the clone control menu will look like this:

```
<MENU>
CLONE= SLAVE
```

a. If the clone control mode displayed is correct, then press the (↑) arrow key to proceed to the next menu.

b. If you wish to change the clone mode, press the ENTR key. The data entry screen will appear as follows:

```
<DATA>
CLONE>SLAVE
```

NOTE

The = sign has been replaced with the > sign, indicating the data entry mode.

c. To change the clone mode to MASTER, scroll through the values using the arrow keys until MASTER is displayed and then press ENTR. The screen will look like this:

```
<MENU>
CLONE= MASTER
```

d. The display will remain in the current menu selection with the new data and the = sign displayed for verification.

A1-3.7 Zeroize Receiver-Transmitter.

After pressing the (↑) key, the zeroize receiver-transmitter menu will look like this:

<MENU>
ZEROIZE RADIO?

a. After pressing the ENTR key, the display will appear as follows:

ZEROIZE RADIO?
ARE YOU SURE??

b. Pressing the ENTR key again will zeroize the programmed data in the receiver-transmitter. If you do not wish to zeroize the receiver-transmitter at this time press the CLR key to exit the zeroize menu.

A1-3.8 Equipment Shutdown.

Shut down the frequency fill device using any of the following methods:

a. Place the receiver-transmitter volume switch in the OFF position.

b. Remove the programming cable from the receiver-transmitter.

c. The frequency fill device will automatically turn off approximately 60 seconds after the last key is pressed.

Section III. EMERGENCY OPERATION

Not Applicable.

CHAPTER A2
THEORY OF OPERATION

A2-1 GENERAL.

This chapter describes the theory of operation of the frequency fill device. From both technical and operational standpoints, the frequency fill device is designed to be a component of a communications system.

Section I. FUNCTIONAL SYSTEM(S) OPERATION

A2-2 FUNCTIONAL SYSTEM(S) OPERATION.

(See Figure A2-1.) The frequency fill device is a hand-held data transfer and programming unit which allows the user to enter, query, and/or upload/download the operating parameters of Radio Set AN/PRC-139(C). A line-by-line menu driven data entry system is employed, prompting the user for the appropriate programming information on a 16-character by 2-line dot matrix LCD backlit display. A 16-key matrix keypad is provided for user data entry. Data is transferred serially between the receiver-transmitter and the frequency fill device via an external cable connection. The frequency fill device cannot be used to zeroize or load crypto keys.

The frequency fill device consists of a single circuit card assembly (CCA) accommodating all of the circuitry as well as electrical connections and/or mounting for the display, keypad, and the external 9-pin D-subminiature connector. The CCA consists of an 8-bit microcontroller with on-chip program and data memory, non-volatile EEPROM memory, an address latch, RS-232C drivers/receivers, pulse-width modulated (PWM) drivers/receivers, display contrast control circuitry, power control and regulation circuitry, and interfaces to the LCD display and 16-key matrix keypad. The microcontroller activates the appropriate discrete control signals and transfers data to and from peripheral devices using its 8-bit address/data bus under the control of the embedded program stored in EEPROM.

Figure A2-1. Frequency Fill Device, Simplified Block Diagram

Section II. FUNCTIONAL OPERATION OF ELECTRONIC CIRCUITS

A2-3 MICROPROGRAMMER CCA.

The frequency fill device consists of a single circuit card assembly (microprogrammer CCA), LCD display, 16 key keypad, and external 9-pin D-subminiature connector. Figure A2-1 provides the block diagram for the microprogrammer CCA as well as the frequency fill device. As shown, the microprogrammer CCA consists of the following functional elements:

a. An 8-bit microcontroller with on-chip program and data memory

b. LCD display module and interface

c. A backlight control circuit to provide light and additional visibility in limited light situations

d. A contrast control circuit to vary the display contrast

e. A keypad and interface circuit

f. Power-up reset circuit

g. A power control and protection circuit

h. PWM interface

i. RS-232C interface

Section III. FUNCTIONAL OPERATION OF MECHANICAL ASSEMBLIES

Not Applicable.

CHAPTER A3
MAINTENANCE

A3-1 GENERAL.

This chapter provides organizational maintenance instructions for the frequency fill device. This includes operational checkout, inspection and preventive maintenance, troubleshooting, and removal/replacement procedures.

A3-2 BUILT-IN DIAGNOSTICS.

On power-up, the microprogrammer CCA executes limited built-in diagnostic functions on the unit. The microcontroller onboard RAM is verified on power-up by reading and writing alternating checkerboard patterns to all 256 bytes with any fault conditions displayed as an *INTERNAL RAM FAULT*. The integrity of the PWM serial connection between the radio and the frequency fill device is also verified on power-up with a communications fault displayed as *RADIO FAULT* or NO RADIO REPLY.

A3-3 OPERATIONAL CHECKOUT.

Perform the following procedure to check the frequency fill device for normal operation. These checks should be performed when equipment is used for the first time or when there is a possibility that the equipment has been damaged.

a. Connect the programming cable (P/N SS-3500276-501) provided with the frequency fill device to the audio accessory connector on the receiver-transmitter. Ensure that a charged battery is connected to the receiver-transmitter.

b. Turn the receiver-transmitter volume switch to a mid-range position.

c. Press any key on the frequency fill device keypad. Observe that the 16-character display (1, Figure A4-1) displays the following initial configuration menu (assuming a 136-174 MHz receiver-transmitter):

BAND=136-174 MHz PROGRAM RADIO ?

d. Press the LAMP key (4, Figure A4-1) several times. Observe that depressing the LAMP key turns the frequency fill device display backlighting on and off.

e. Verify that pressing the up arrow (↑) key (6, Figure A4-1) incrementally increases display contrast.

f. Verify that pressing the down arrow (↓) key (5, Figure A4-1) incrementally decreases display contrast.

g. To initiate the TEST MODE, press and hold any key on the keypad. After a 3 second delay, TEST MODE will appear on the display. When the key is released, the LCD will simultaneously display the same character in all 32 locations, changing characters at a rate of 2 per second until all channels have been displayed.

A3-4 SERVICING.

A3-4.1 Servicing Intervals.

Table A3-1 provides recommended service intervals.

Table A3-1. Recommended Service Intervals

Task	Recommended Interval			
	D	W	M	Q
Visual inspection (see paragraph A3-4.2)	X			
Preventive maintenance:				
Inspection (see paragraph A3-4.3.1)		X		
Cleaning (see paragraph A3-4.3.2)		X		

D = Daily
W = Weekly
M = Monthly
Q = Quarterly

A3-4.2 Inspection.

Many potential or existing faults can be detected by making a visual inspection of the equipment. For this reason, a complete visual inspection should be made on a routine basis and whenever the frequency fill device is inoperative.

NOTE

If any discrepancies are observed, return the unit to higher level maintenance.

At a minimum, the following items should be inspected by the operator and/or organizational maintenance:

a. Inspect the equipment covers and front panel for condition of finish and panel markings.

b. Inspect for dents, punctures, and warped areas.

c. Inspect external surfaces for loose or missing screws or washers.

d. Inspect receptacles and connectors for condition of pins, contacts, and mounting.

e. Inspect switches (keys) for mechanical integrity.

A3-4.3 Preventive Maintenance.

The frequency fill device requires very little routine maintenance. At regular intervals, perform the following procedures:

A3-4.3.1 Inspection.

Inspect the frequency fill device as follows:

a. Inspect the equipment cover and front panel for condition of finish and panel markings.

b. Inspect the unit for dents, punctures, or warped areas.

c. Inspect external surfaces for loose or missing screws or washers.

d. Inspect the receptacles and connectors for condition of pins and contacts, and mounting.

e. Inspect the switches (keys) for mechanical integrity.

A3-4.3.2 Cleaning.

Cleaning should be performed to remove accumulated dust and other contaminants. Clean the frequency fill device as follows:

a. Dust the keypad and display with a soft-bristled brush.

b. Remove dirt clinging to the frequency fill device with a clean, lint-free cloth dampened with a mild detergent and water solution. Avoid using abrasive cleaners, as they will scratch the unit's surface.

A3-5 TROUBLESHOOTING.

Table A3-2 describes possible system malfunctions, their probable cause(s), and corrective action required by the operator/repair specialist to return the equipment to a fully operational state. All solutions which suggest replacement of an item assume that the item used to make the replacement is a known good item.

Table A3-2 contains the symptoms of possible system malfunctions which can be acted on by the operator or repair specialist. Only those procedures contained within Table A3-2 are authorized to be performed by the operator. There are no additional repair actions authorized for the repair specialist. Prior to performing any repair actions, the repair specialist should perform the following inspections:

a. The repair specialist should reinspect those items that were inspected by the operator.

b. Inspect the internal components for signs of deterioration, discoloration, or charring. Check for melted insulation and damaged, cracked or broken components.

c. Inspect the printed circuit board for damaged tracks, loose connections, corrosion, or other signs of deterioration.

d. Inspect the interface connectors for excessive wear, looseness, misalignment, corrosion, or other signs of deterioration.

Table A3-2. Organizational Maintenance Guide

Symptom	Possible Cause	Remedy
Display shows INTERNAL RAM FAULT	Fault cannot be isolated/repaired by operator	Return the frequency fill device to the repair specialist for repair
Displays RADIO FAULT or NO RADIO REPLAY	Improper/bad connection to radio	Reconnect programming cable
	Bad programming cable	Replace programming cable
	Fault cannot be isolated/repaired by operator	Return the frequency fill device to the repair specialist for repair
Receiver-transmitter does not accept programming data from the frequency fill device but can be programmed from the base station	Failed programming cable	Replace programming cable
	Fault cannot be isolated/repaired by the operator	Return the frequency fill device to the repair specialist for repair
Display on frequency fill device does not operate (missing characters, no illumination, etc.)	Fault cannot be isolated/repaired by the operator	Return the frequency fill device to the repair specialist for repair
Display on frequency fill device Does not respond to keypad entries	Fault cannot be isolated/repaired by the operator	Return the frequency fill device to the repair specialist for repair

A3-6 REMOVAL/REPLACEMENT PROCEDURES.

CAUTION

Use care in removing and replacing modules to prevent damage to pins and sockets.

CAUTION

The CCA in the frequency fill device contain parts that are sensitive to damage by electrostatic discharge (ESD). Use ESD precautionary procedures (wear grounding wrist straps) when touching, removing, and installing the module.

A3-6.1 Removal/Replacement Procedures - Operator.

(See Figure A4-2.) The first step for any remove/replace procedure is to power down the equipment. Prior to removing or installing any assembly, remove all accessories (antenna, microphone, etc.) as applicable. To replace components into the frequency fill device, reverse the removal instructions unless otherwise stated.

A3-6.1.1 Programming Cable Removal/Replacement.

Remove/replace the programming cable as follows:

a. Loosen the two screws securing the programming cable connector to the bottom of the frequency fill device.

b. Grasp the connector and pull the cable away from the frequency fill device. If the connector does not easily pull away, check to ensure that the screws are completely loosened.

A3-6.2 Removal/Replacement Procedures - Repair Specialist.

The repair specialist at the organizational level is authorized to perform all maintenance actions described for the operator. If the repair specialist is unable to repair the frequency fill device, it must be returned to the depot for repair.

APPENDIX B

OPERATION AND MAINTENANCE INSTRUCTIONS

ORGANIZATIONAL LEVEL

SINGLE STATION AND MULTIPLE STATION BATTERY CHARGERS AND BATTERY RECONDITIONER

CHAPTER B1 OPERATION

B1-1 CONTROLS AND INDICATORS.

B1-1.1 Multiple Station Controls and Indicators.

The only multiple station control is the ON/OFF switch located on the unit rear panel. The operator indicators of the multiple station charger are described in Table B1-1 and illustrated in Figure B1-1. Battery status is indicated by a combination of the indicators and an audible tone, as described in Table B1-2.

Table B1-1. Description of Multiple Station Charger Indicators

Fig & Index Number	Indicator	Function
B1-1	READY	Lights to indicate that battery is fully charged.
B1-2	CHARGE	Lights to indicate that battery is being charged.

Table B1-2. Multiple Charger Battery Status Indications

Battery Status	**READY LED**	**CHARGE LED**	**Tone**	**Notes**
No Battery	Off	Off	None	
Battery Inserted	Off	On	Single Beep	
Charging	Off	On	None	
Charge On Hold (Battery cold)	Off	Single Flash	None	1
Charge On Hold (Battery hot)	Off	Triple Flash	None	2
Charge Complete (Normal Operation)	On	Off	Triple Beep (high tone)	
Charge Complete (Battery hot while charging	Triple Flash	Off	None	3
Battery Failed	Flashing	Off	None	4
Standby	Off	Off	None	5

Notes:
1. A cold battery will be placed on trickle charge until it has reached charging temperature, at which point it will be placed on fast charge.
2. Charging is suspended completely for a battery which is too hot. Charging returns to normal when the battery has reached proper temperature.
3. Note that the battery may not be fully charged due to high temperature charge termination.
4. Battery has failed. The charger was unable to properly charge the battery, and the battery *should not be used*.
5. The charger will enter **Standby** mode if the source voltage drops below 20 volts. When correct voltage is restored, the charger will wait an additional minute, then resume operation.

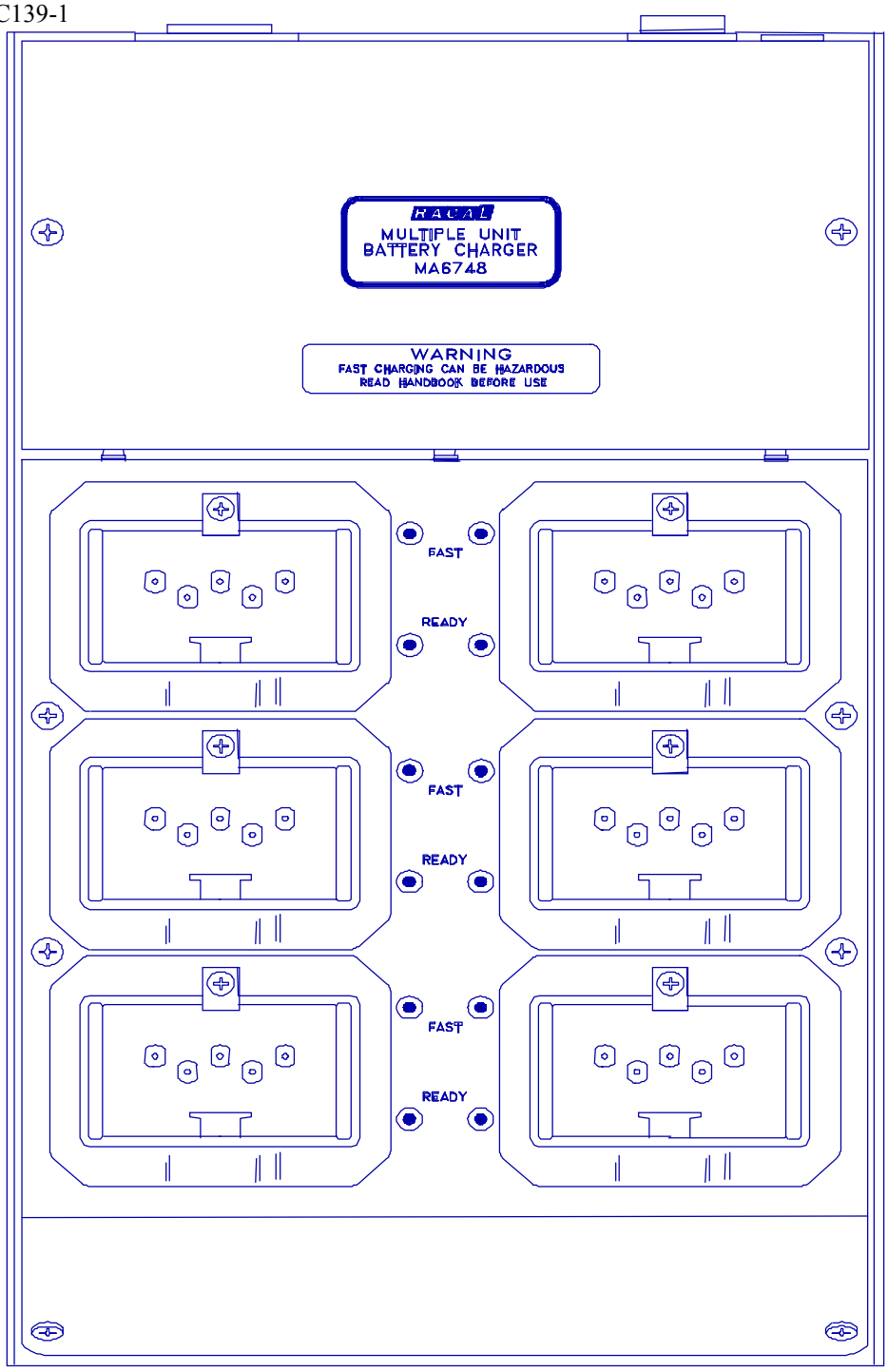


Figure B1-1. Multiple Station Charger Indicators

B1-1.2 Single Station Charger Controls and Indicators.

The only single station control is the ON/OFF switch located on the unit rear panel. All operator indicators of the single station charger are described in Table B1-3 and illustrated in Figure B1-2.

Table B1-3. Description of Single Charger Indicators

Fig & Index Number	Indicator	Function
B1-2-1	READY (green LED)	Lights when fast charge completed. Battery ready for use
B1-2-2	STANDBY	Lights to indicate hot or cold batteries are presented to the charger. In standby, the batteries will receive a trickle charge.
B1-2-3	FAST CHARGE	Lights to indicate that fast charge is in operation.

B1-1.3 Reconditioner Controls.

The battery reconditioner operation is controlled by internal programming that is accessed through the FUNCTION soft key on the right front of the top panel. Pressing the FUNCTION key illuminates the FUNCTION LED and accesses the menu mode. Menu mode is used to set the individual program (PRIME, AUTO, or CHARGE) of each of the four battery sleeves and to set the global target capacity and LCD contrast for the reconditioner. Sleeve programming can only be changed when the sleeve is empty. Complete details of reconditioner programming are contained in the user manual packed with the reconditioner.

B1-1.4 Reconditioner Indicators.

The battery reconditioner has three battery status LEDs (RUN, READY, and FAIL), a POWER LED, and an 80 character liquid crystal display (LCD). The basic status of the batteries is indicated by the LEDs, with additional information contained in the global and detailed displays of the LCD. The LED indications are explained in Table B1-4. The reconditioner is illustrated in Figure B1-3.

The LCD is arranged in multi frame formats. On the Global Display, the status of all batteries in service can be observed simultaneously. The first line is divided into four fields, one for each battery station. On the second line, the average cell voltages of all batteries are displayed in bar graph form. Pressing a Display key allows access to the Detailed Display for an individual battery.

The Global Display is the default display. The first line of the display contains battery status messages such as: EMPTY, when no battery is present, CAP: xxx%, indicating the battery is ready and has a final capacity of xxx% of the rated capacity, DONE, when a battery was charged in CHARGE mode, and FAIL 26, when the battery has a voltage problem. The bottom line of the display shows the average cell voltage of each battery in bar graph form. The voltage range of the bars is divided into SHORT, ZONE 1, ZONE 2, ZONE 3, and SOFT. The possible displays in each zone are described in Table B1-5.

Pressing the Display key shows the Detailed Display which contains the average cell voltage, capacity readings, and Fault Code (if applicable). The display can show up to three capacity readings for residual, true and final capacities. A complete list of messages and fault codes is contained in the separate User's manual included with each reconditioner.

Table B1-4. Description of Reconditioner Indicators and Audible Signals

Indicator or Signal	Function
RUN steady RUN blinking	Battery service in progress Battery too cold for charge; will proceed when normal.
READY steady READY blinking	Battery ready; meets or exceeds target. Battery ready; charge mode only
FAIL steady FAIL flashing	Program completed. Target not met. Battery voltage fault; cannot be corrected.
POWER steady POWER flashing	Analyzer operational. Analyzer on hold due to high temperature condition; resumes when normal
READY/FAIL flashing	Battery hot; program terminated (CHARGE mode only)
Single beep tone	Battery inserted or key pressed
High pitch triple beep (2400 Hz)	READY. successful service
Low pitch triple beep (674 Hz)	Completion, target not met
Repetitive beeping	Intermittent battery
Continuous tone	Shorted battery
Wailing sound	Wrong polarity (Remove battery immediately)

Table B1-5. Description of Cell Voltage Zone Indicators

Zone Indicator	Description
SHORT	If a battery cannot clear the SHORT zone in 2 seconds, the message "SHORTED" appears and a continuous tone is heard. Remove battery from slot and discard.
ZONE 1	Three fault types may occur in this zone: "PARTIAL SHORT", "LOW VOLTAGE", and "DEPRESSED VOLTAGE". Each fault type has a different charge time-out. Batteries with these fault types are non-correctable.
ZONE 2	For a successful charge, a battery must enter and remain in Zone 2. Full charge is detected by either the negative slope or the peak voltage timer methods.
SOFT	A soft battery is unable to clamp the charge voltage. The program is terminated; the battery is unserviceable.

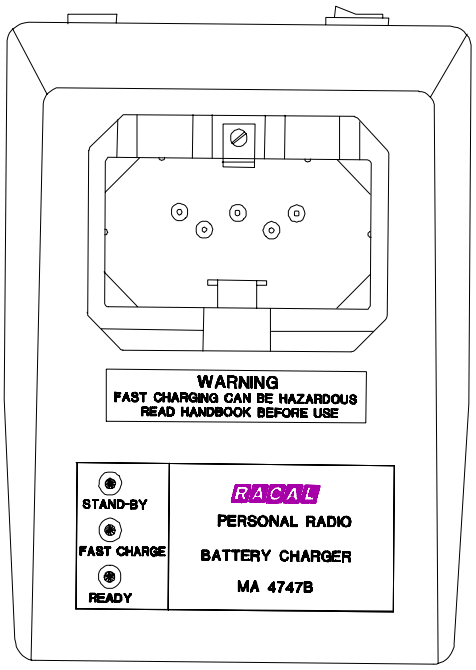


Figure 1-2. Single Station Charger Indicators

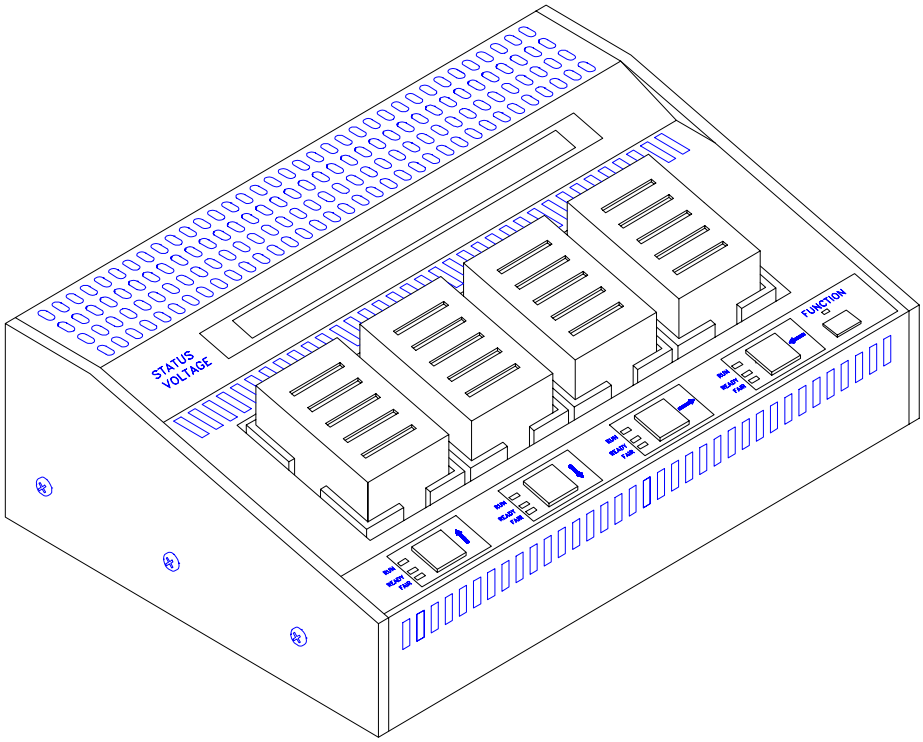


Figure B1-3. Battery Reconditioner

B1-2 BATTERY CHARGING.

Multiple station and single station battery chargers are available for charging the NiCad batteries used in the hand-held radio. The following paragraphs describe the methods for charging NiCad batteries. Charging is accomplished automatically by the chargers. The battery reconditioner also can be used to charge batteries.

B1-2.1 Battery Charging Methods.

Methods of charging the NiCad batteries are described in the following paragraphs.

B1-2.1.1 Constant Current-Normal Rate.

This is the normal method for charging a battery. For a 1.45 AH battery, for example, the charging current should be 145 mA.

B1-2.1.2 Fast Charging.

Fast charging is used to fully charge a battery in less time than the normal charge rate. For a 1.45 AH battery, for example, the charging current should be 500-600 mA.

B1-2.1.3 Trickle Charge.

A NiCad battery will normally self-discharge over time. A trickle charge is used to keep a battery fully charged after being charged at a higher rate. Nominal trickle charge current for a 1.44 ampere-hour (AH) battery is 50 mA continuous.

B1-2.1.4 Temperature-Controlled Charging.

Temperature-controlled charging is used in the single station charger. When a NiCad cell reaches its full capacity, an increase in temperature occurs due to the reaction of oxygen and cadmium inside the cell. At excessive temperatures, the single station and multiple station chargers and reconditioner will automatically switch off.

B1-2.1.5 Negative Slope Controlled Charging.

Both the multiple charger and the reconditioner use the negative slope method the detect full charge. Negative slope refers to the fact that when a NiCad battery reaches full charge, the voltage per cell, which rises during the charging cycle, exhibits a slight, but detectable decrease.

B1-2.1.6 Full Charge Detection.

When full charge is determined in both the single station and multiple station battery charger, the charger automatically places the battery on trickle charge, keeping it at full capacity and ready for use.

B1-2.1.7 Plateau Timer.

With some batteries, particularly new or older batteries, a cell mismatch condition may be present. In this case, not all cells in the battery will reach their voltage peaks at the same time. The result is that the battery's overall voltage will appear to level off, or plateau, and the negative slope will not be detectable. When this occurs, the fast charge is ended by the plateau timer, which is maintained by the microprocessor. Full charge detection by this method takes only slightly longer than detection by the Negative Slope method.

B1-3 BATTERY CARE.

NiCad batteries have unique needs that must be met in order to maintain peak performance and achieve maximum life.

B1-3.1 Memory.

NiCad batteries will often fail prematurely due to voltage depression, a phenomenon often referred to as memory. Memory is caused by the build-up of a crystalline formation known as dendrite, on the cell plates. The build-up occurs when a battery is repeatedly charged without first being sufficiently discharged. The hand-held radio includes a low battery warning indicator which indicates when the battery needs charging. The advanced charging techniques used in the multiple station and single station chargers reduce the build-up of memory in NiCad batteries. However, since these chargers act solely as a charger, it may not prevent memory from occurring. Use of a battery reconditioner will exercise and, if required, recondition a battery, correcting conditions such as memory and cell mismatch, keeping the batteries at peak performance. It will also positively identify faulty batteries so they can be removed from service.

B1-3.2 Reconditioning.

The effects of "memory" can be removed through the reconditioning process. With the reconditioner selector switch set to AUTO, the battery is first discharged to 1 volt/cell to measure residual capacity. If the residual capacity is below target, the battery is fully charged and a second discharge is applied. If the resulting capacity is still below target, there is a controlled deep discharge of the battery. After a brief neutralizing period, a full recharge is applied and the battery is again discharged to measure the improved capacity. The recondition program does not correct batteries that have voltage errors (shorted cells) or high internal leakage.

B1-3.3 Self-Discharge.

Most rechargeable batteries exhibit a certain amount of self-discharge. In the case of a NiCad battery, this lose is approximately 10% of its energy in the first 24 hours after a full charge, which tapers to about 10% per month thereafter. The multiple station and single station chargers automatically place a battery on trickle charge when the fast charge has been completed, keeping the battery ready for use in full capacity.

NOTE

If not required for immediate use, batteries should be occasionally left in the charger under trickle charge for a few hours to help correct any imbalance of cells and to ensure all cells are fully charged.

B1-3.4 Overcharging and Venting.

As a NiCad battery ages, its capacity will gradually start to decrease. As a result, the amount of time it will take to charge will decrease as well, since it is no longer able to store as much energy. In multi-cell batteries (which most batteries are), this can lead to a condition known as cell mismatch, where one cell in the battery will reach full charge before the others, and will then begin to overcharge, while the other cells are still charging.

When a NiCad is overcharged, gasses will build up in the cell, and if the pressure becomes excessive, venting will occur. A popping or hissing sound may be heard when venting happens. There is no danger to the equipment or from the battery. However, each time venting does occur, the cell's capacity is further decreased, accelerating its rate of deterioration and ultimate failure.

B1-3.5 Temperature Effects on NiCad Batteries.

Extended periods of high temperature reduce NiCad lifetime. As a general rule, every 10°C increase in average temperature cuts cell life in half.

B1-3.6 Battery Initialization using the Chargers.

Before use, batteries can be initialized using the chargers as follows:

a. Insert the new NiCad battery into the charger and charge for 14-16 hours before being placed in operation.

b. Remove the battery from the charger.

c. Place the battery to the receiver-transmitter perpendicular to the bottom of the receiver-transmitter and rotate one-quarter turn to lock it in position. (See Figure 2-2.)

d. Use the hand-held radio until the battery is fully discharged.

e. Recharge the battery until the charger indicator again indicates that the battery is fully charged.

B1-3.7 Battery Initialization using the Reconditioner.

Before initial use, the reconditioner PRIME function can automatically initialize NiCad batteries. The analyzer repeatedly exercises the battery (charging and discharging) until peak performance is reached (when there is less than a 5 per cent improvement in capacity between cycles).

CHAPTER B2 THEORY OF OPERATION

B2-1 SINGLE STATION CHARGER.

The single station charger provides the control and measurement functions necessary for recharging of a single NiCad battery of Radio Set AN/PRC-139(C). The charger uses three LEDs (STANDBY, READY, and FAST CHARGE), combined with audible tones, to advise the user as to the status of each battery in the charger. Operation of the charger relies on a voltage sensing circuit which detects the fall in battery voltage at full charge and switches from fast charge to trickle charge. Fast charging is inhibited when the battery temperature is outside 0°C (32°F) and 50°C (122°F). If the battery is outside the temperature limits, a trickle charge is applied. This is indicated by an amber STANDBY LED until the temperature is acceptable. When the temperature is acceptable, the FAST CHARGE LED will illuminate and the STANDBY LED will extinguish. The charge condition is indicated by an amber FAST CHARGE LED. The charge will be completed in nominally 3 hours. When the charge is complete and the battery is ready for use, a trickle current is applied and a green READY LED indicates the condition.

B2-2 MULTIPLE STATION CHARGER.

B2-2.1 General.

The multiple station charger provides the control and measurement functions necessary for recharging up to six NiCad batteries of Radio Set AN/PRC-139(C). It includes a charge control circuit card assembly (CCA) which simultaneously and independently controls the charging of up to six batteries and allows rapid charging of batteries while preventing damage from temperature extremes and overcharging. The CCA monitors battery temperature and inhibits the quick charge function if the battery temperature is not within the range of 0°C (32°F) and 50°C (122°F). Charging is inhibited if a defective battery is inserted into the charger. The charger uses two LEDs (READY and CHARGE) to advise the user as to the status of each battery in the charger.

B2-2.2 Battery Temperature Sensors.

In addition to protecting the battery from damage due to overheating, the battery temperature sensor also ensures that the battery is within its charging temperature requirements before and during fast charging. The battery temperature sensor consists of a thermistor, which is integrated into the battery pack. Batteries can only be fast charged when the temperature is between 5°C and 49°C (41°F to 120°F). Damage to the battery may occur if fast charge is applied outside of this range. The multiple station battery charger will place a cold battery on trickle charge until it has warmed up sufficiently, the trickle charge helping to warm the battery quicker. No charge will be applied to a hot battery until it has sufficiently cooled. Both the single and multiple station chargers show charging status via light emitting diode (LED) indicators. The single station has three LEDs (READY, FAST CHARGE, and STANDBY), while the multiple station has two LEDs associated with each insert (READY or CHARGE).

B2-2.3 Charging Methods.

A pulsed charged method is used to increase charge efficiency and battery performance. This allows batteries to charge faster, while remaining cooler than with conventional charging methods. This also helps reduce the memory phenomenon that nickel-cadmium (NiCad) batteries exhibit.

B2-3 BATTERY RECONDITIONER.

B2-3.1 General.

The battery reconditioner can analyze the condition, charge, or recondition up to four NiCad batteries simultaneously. Each of the four battery stations is equipped with RUN, READY, and FAIL LEDs. There is an 80 character LCD display that shows the status of all inserted batteries simultaneously as well as displaying the average cell voltages in a bar graph format. The reconditioner has four operational modes: PRIME, CHARGE, AUTO, and STANDBY, described in the following paragraphs.

B2-3.2 PRIME Mode.

PRIME mode is used to prepare new batteries for use and condition batteries that have been in storage. The analyzer repeatedly exercises (charges and discharges) the battery until peak performance is reached. The battery is first discharged to 1 volt/cell then recharged. A second discharge/charge cycle is applied, giving a second capacity measure. If the second capacity is more than a 5 point improvement over the first, a further cycle is applied until the improvement is less than 5 points.

B2-3.3 CHARGE Mode.

CHARGE mode quick charges the battery to full capacity then switches to trickle charge. Full charge is detected by the negative slope method. Negative slope refers to the fact that when a NiCad battery reaches full charge, the voltage per cell, which rises during the charging cycle, exhibits a slight, but detectable decrease.

The analyzer recognizes a partially or fully charged battery and shortens the charge time accordingly. A shorter than average charge also occurs on batteries that ahve low capacity due to "memory", age, and other deficiencies. All charging modes use a reverse load pulse charge method that aids in the recombination of gases and improves battery life.

B2-3.4 AUTO Mode.

AUTO mode is the mode generally used for battery maintenance. The battery is first discharged to 1 volt/cell to measure residual capacity. If the capacity meets or exceeds target, If the residual capacity is below target, the battery is fully charged and a second discharge is applied. If the resulting capacity is still below target, there is a controlled deep discharge of the battery. After a brief neutralizing period, a full recharge is applied and the battery is again discharged to measure the improved capacity. The recondition program does not correct batteries that have voltage errors (shorted cells) or high internal leakage.

B2-3.5 STANDBY Mode.

A NiCad battery should not be left on trickle charge for prolonged periods, as "memory" degradation occurs, but a fully charged battery rapidly self-discharges (up to 10 per cent of capacity in the first 24 hours). STANDBY mode exercises a battery with an automatic discharge-charge cycle every 30 days. Only one battery per analyzer is placed on the scheduled discharge-charge at a time.

CHAPTER B3 ILLUSTRATED PARTS BREAKDOWN

Section I. INTRODUCTION

B3-1 GENERAL.

The Illustrated Parts Breakdown (IPB) lists, illustrates, and describes the parts used in the Scope Shield Charger Assembly, Single (SS-4100846-501), Charger Assembly, Multiple (SS-4100885-501), and Battery Reconditioner (SS-1600320-1). The items are manufactured by Racal Communications, Inc., Rockville, Maryland.

B3-2 MAINTENANCE PARTS LIST.

The Maintenance Parts List (MPL), (Section II), consists of the complete systems divided into main groups. The main groups are broken down into assemblies, subassemblies, and details. The next higher assembly (NHA) is indicated for each separately illustrated item. Each assembly and subassembly listed is followed immediately by its component parts. In general, the assemblies and parts installed at the time the end item was manufactured are listed and identified in the manual. When an assembly/part (including vendor items) different from the original was installed during manufacture of the later items, series, or blocks, all assemblies and parts are listed (and "Usable on" coded). However, when the original assembly or part does not have continued application, only the preferred assembly or part is listed. When an assembly/part installed during modification, and the original does not have continued application, only the preferred item is listed. Interchangeable and substitute assemblies and parts, subsequently authorized by the Government, are not listed in this manual. When a standard size part can be replaced with an oversize/undersize part, the latter parts, showing sizes, are also listed.

a. Figure and Index Number Column. This column lists the figure and index number of each part illustrated in the related figure. The index numbers are in numerical sequence and indicate order of disassembly except where the order does not apply. Index numbers identify each part number shown in the related figure. Assemblies which have detail parts indexed are not indexed unless; the assembly is illustrated completely assembled on the same illustration; or it is identified as an assembly by bracketing or circling of components. When a group of parts (bolt, washer, nut) is used at a specific location for attachment purposes, one index number assigned is sufficient. The index number appears on the same line as the first part composing the group.

b. Part Number Column. This column lists the contractor's part number (drawing number), including dash numbers, assigned to each part. Vendor part numbers are listed when parts are identical to the contractor used part. Those parts which have Government Standards numbers assigned have the Government Standards number listed. Parts altered or selected for special fit, tolerance, etc., from vendor, commercial, or Government Standards part number of the altered or selected part follow the part description in the Description column. Item(s) of supply part number(s) and Contractor and Government Entity (CAGE) that is stocked, stored, and issued by the Government as identified by the Government during the initial provisioning process shall be identified by an (*) sign preceding the part number one space to the left. Government Furnished Equipment (GFE) and Contractor Furnished Equipment (CFE), covered by separate manuals are listed and identified by a number sign (#) inserted flush right following the part number. Decalcomania, metal-cals, and vinyl film markings are considered as parts. The part number for each marking will be followed by a asterisk (*) symbol inserted flush right. Requisition the marking in accordance with the requirements of AFR 6-1.

c. CAGE Column. This column contains a five-digit code number following the part number denoting the procuring vendor. The source of vendor code numbers is the CAGE for Manufacturer Cataloging Handbook H4-1, H4-2, and H4-3. When a CAGE for the appropriate manufacturer or Government agency is not published in the current issues of the H4 handbook, the word "none" will appear in this column.

d. Description Column. This column contains the description of all items appearing on the MPL. The indentation headed "1" through "7" consists of the approved item name, as found in the Federal Item Identification Guide for Supply Catalog Handbook H6-1, or is in accordance with the contractor's drawing title. The description contains modifiers necessary to identify the particular item. Additional information following the item description may include the following: a list of alternate part numbers to give stock ordering information; exceptions to the Usable On Code for the item; and references to preceding and subsequent figures concerning assemblies and subassemblies. This data is considered an integral part of the item description assuring the correctness of repair maintenance procedures.

e. Attaching Parts. Items used to attach parts or assemblies to each other are listed immediately after the part. The attaching parts have the same indentation code as the parts attached. The code (AP) appears on the same line with and immediately following the attaching part item.

f. Units Per Assembly. This column contains the number of units required per assembly and/or subassembly. If more than one assembly is required, the total number of assemblies is listed. When an assembly or subassembly is listed more than once, the total number of units per assembly or subassembly appears the first time and REF for subsequent listings.

g. Usable on Code Column. This column shows the Usable On Codes for systems, assemblies, and parts indicating specific usability by part number. Usable on code explanations are located at the bottom of the applicable page. The codes A, B, C, etc., when shown within a group, relate the part back to the same coded part within the next higher assembly. When this column is left bank, an assembly or part is common to all part number variation of the next higher assembly.

h. Source, Maintenance, and Recoverability (SMR) Codes. This manual contains Joint Military Services Uniform SMR codes. Detailed coding criteria may be obtained from T.O. 00-25-195.

B3-3 NUMERICAL INDEX.

The Numerical Index (Chapter 3, Section III) is compiled in accordance with the numerical part number filing system described in paragraph a.

a. Part Number Column. This column contains all the part numbers that appear in the Maintenance Parts List and part numbers that have been assigned to detail parts assembled into the end article. The order of procedure establishing the precedence in which the part numbers are listed is explained below. The order of precedence in the first position of each part number is Letters A through Z, Numerals 0 through 9.

NOTE

Alphabetical O's are considered as numerical zeroes in all positions in each part number.

The order of precedence in the second and succeeding positions in each part number is as follows:

(1) Space (blank column).
(2) Diagonal (/).
(3) Period (.).
(4) Dash (-).
(5) Letters A through Z.
(6) Numerals 0 through 9.

The following is a sample of part numbers arranged in alphabetical-numerical sequence used in the Numerical Index.

AN931-4-13	B2	16.W2
A2460	S/1	16W060
A32	121873	32P0101
B12	128	39A45

b. Figure and Index Number Column. For each part number, the figure or figure and index number refers to the MPL where the parts relationship is shown. When an assembly or part has not been assigned an index number, the figure and index number of the preceding part in the MPL is used with the letter "F" before the figure, such as F7-7. The letter "F" denotes "follows".

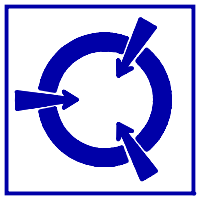
B3-4 REFERENCE DESIGNATION INDEX.

The Reference Designation Index (Chapter 3, Section IV) is listed by figure as it appears in the MPL, then in alphabetical-numerical order, the reference designations used in schematic diagrams and instruction books. Opposite the reference designation is listed the figure index number as shown in the MPL.

B3-5 ELECTROSTATIC DISCHARGE (ESD) SENSITIVE DEVICES.

a. This technical order contains parts and assemblies sensitive to damage by ESD. T.O. 00-25-234 should be consulted for specific information on how damage can occur to electronic parts, assemblies, and equipment by ESD and the control measures to be taken to protect against such damage.

b. Illustrations contained within this manual which depict ESD parts are further identified by the use of the following symbol affixed in the lower right-hand corner of each applicable illustration.

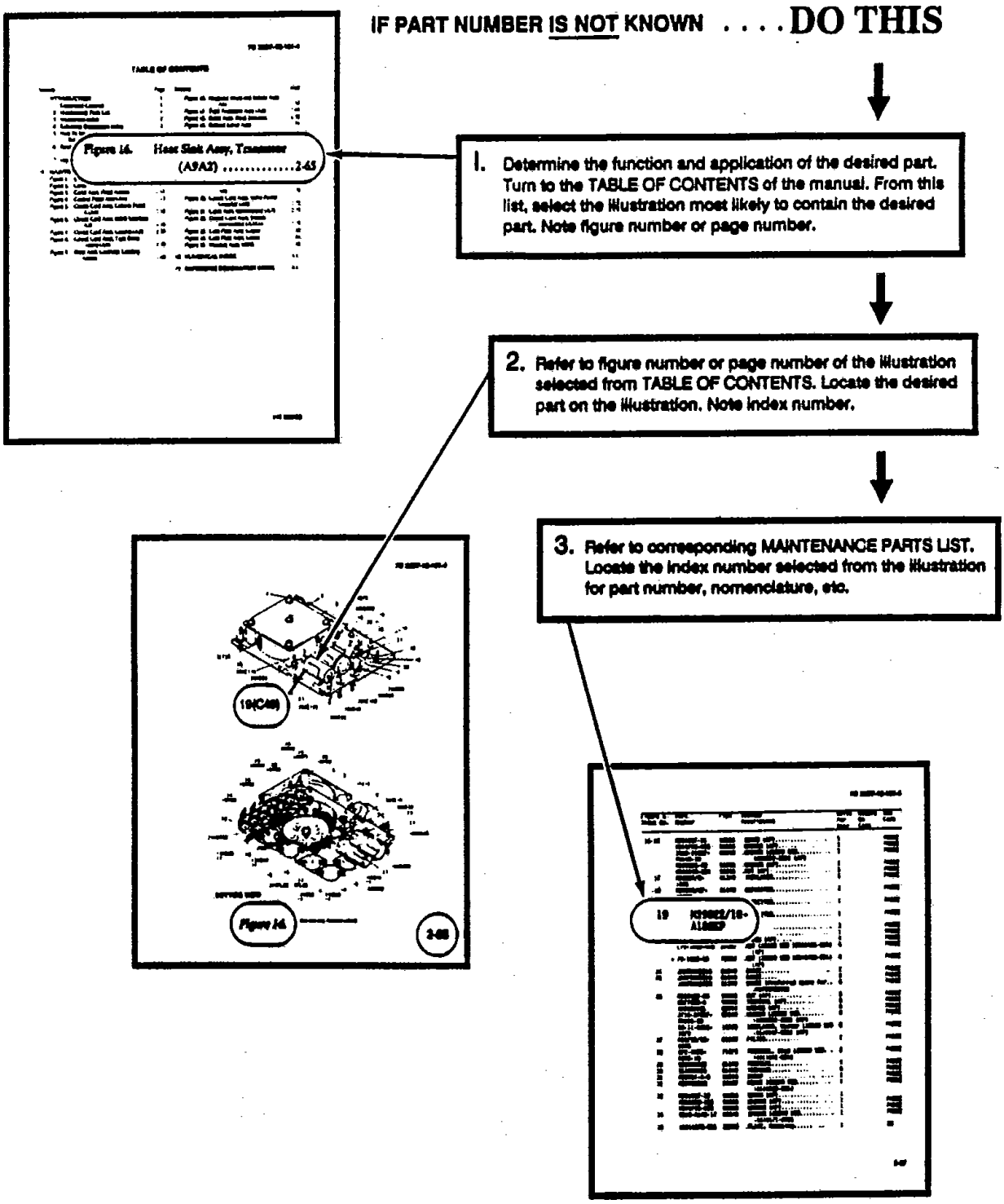


c. The MPL contained within this manual with ESD sensitive parts are identified by the following symbol (ESD). These symbols are placed in the extreme right of the description column for the item as ESD sensitive.

B3-6 CAGE CODE SUMMARY.

CAGE Code	Manufacturer
05972	Loctite Corp.
23386	Racal Communications, Inc.
43678	Cadex
71400	Bussman
75915	Littlefuse
81349	Military Specifications
92194	Alpha Wire Corp.

HOW TO USE THE ILLUSTRATED PARTS BREAKDOWN


IF PART NUMBER IS NOT KNOWN . . . . DO THIS
1. Determine the function and application of the desired part. Turn to the TABLE OF CONTENTS of the manual. From this list, select the illustration most likely to contain the desired part. Note figure number or page number.
2. Refer to figure number or page number of the illustration selected from TABLE OF CONTENTS. Locate the desired part on the illustration. Note index number.
3. Refer to corresponding MAINTENANCE PARTS LIST. Locate the index number selected from the illustration for part number, nomenclature, etc.

HOW TO USE THE ILLUSTRATED PARTS BREAKDOWN

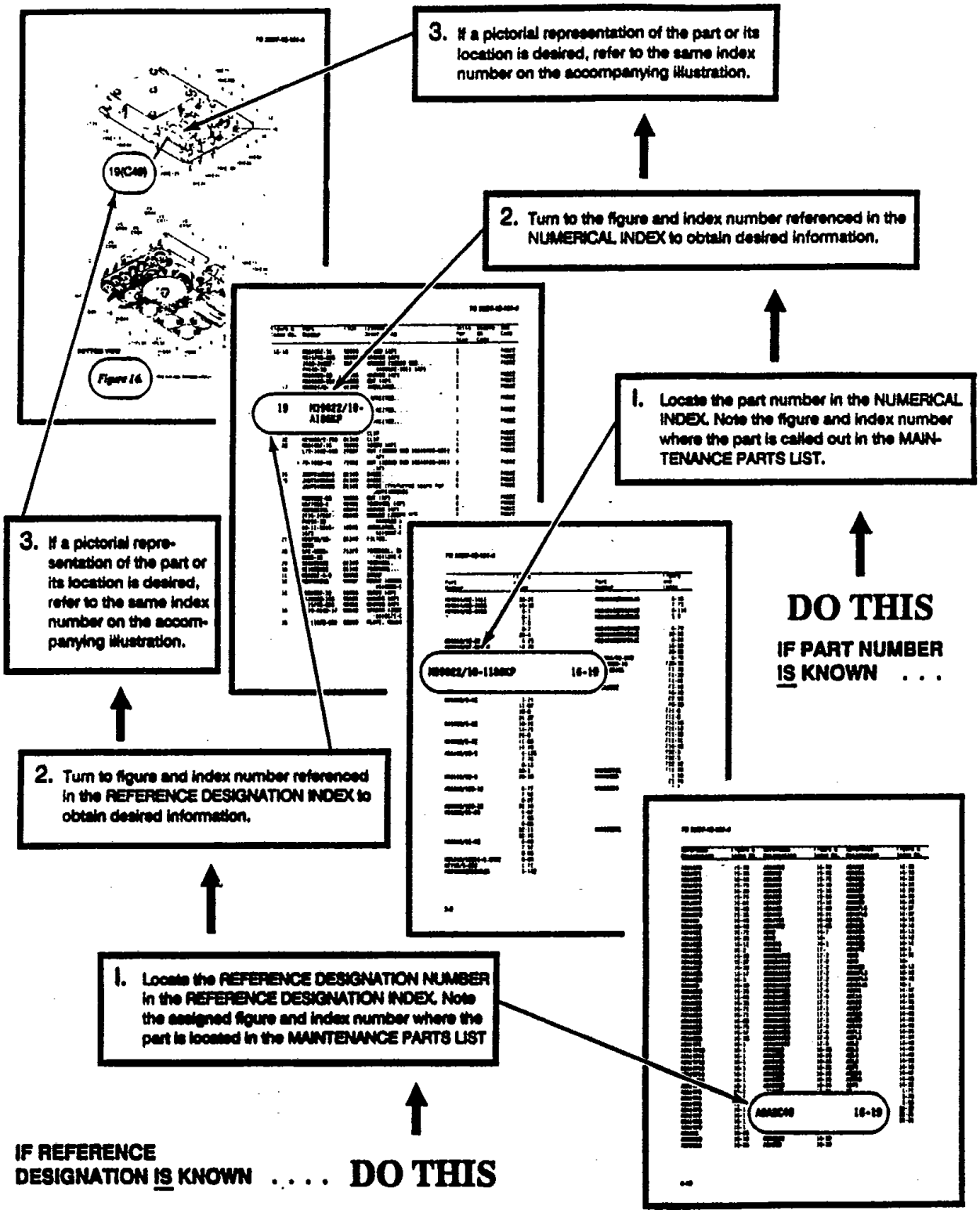

3. If a pictorial representation of the part or its location is desired, refer to the same index number on the accompanying illustration.
2. Turn to the figure and index number referenced in the NUMERICAL INDEX to obtain desired information.
1. Locate the part number in the NUMERICAL INDEX. Note the figure and index number where the part is called out in the MAINTENANCE PARTS LIST.
DO THIS
IF PART NUMBER IS KNOWN . . .
3. If a pictorial representation of the part or its location is desired, refer to the same index number on the accompanying illustration.
2. Turn to figure and index number referenced in the REFERENCE DESIGNATION INDEX to obtain desired information.
1. Locate the REFERENCE DESIGNATION NUMBER in the REFERENCE DESIGNATION INDEX. Note the assigned figure and index number where the part is located in the MAINTENANCE PARTS LIST
IF REFERENCE DESIGNATION IS KNOWN . . . . DO THIS

Figure B3-1. Charger Assembly, Single

Section II. MAINTENANCE PARTS LISTS

Table B3-1. Charger Assembly, Single

Figure & Index No.	Part Number	CAGE	Description 1 2 3 4 5 6 7	Units per Assy	Usable on Code	SMR Code
B3-1	SS-4100846-501	23386	Charger Assembly, Single ..... (see T.O 31R2-2PRC139-3 for breakdown)	0001		PAODDT

Figure 3-2. Charger Assembly, Multiple

Table 3-2. Charger Assembly, Multiple

Figure & Index No.	Part Number	CAGE	Description 1 2 3 4 5 6 7	Units per Assy	Usable on Code	SMR Code
B3-2	SS-4100885-501	23386	Charger Assembly, Multiple ..... (see T.O 31R2-2PRC139-3 for breakdown)	0001		PAODDT
B3-2-1 (F1)	GDC-2A	71400	Fuse, 2 Amp.....	0001		PAOZZN
B3-2-2 (F2)	218001	75915	Fuse, 1 Amp.....	0001		PAOZZN

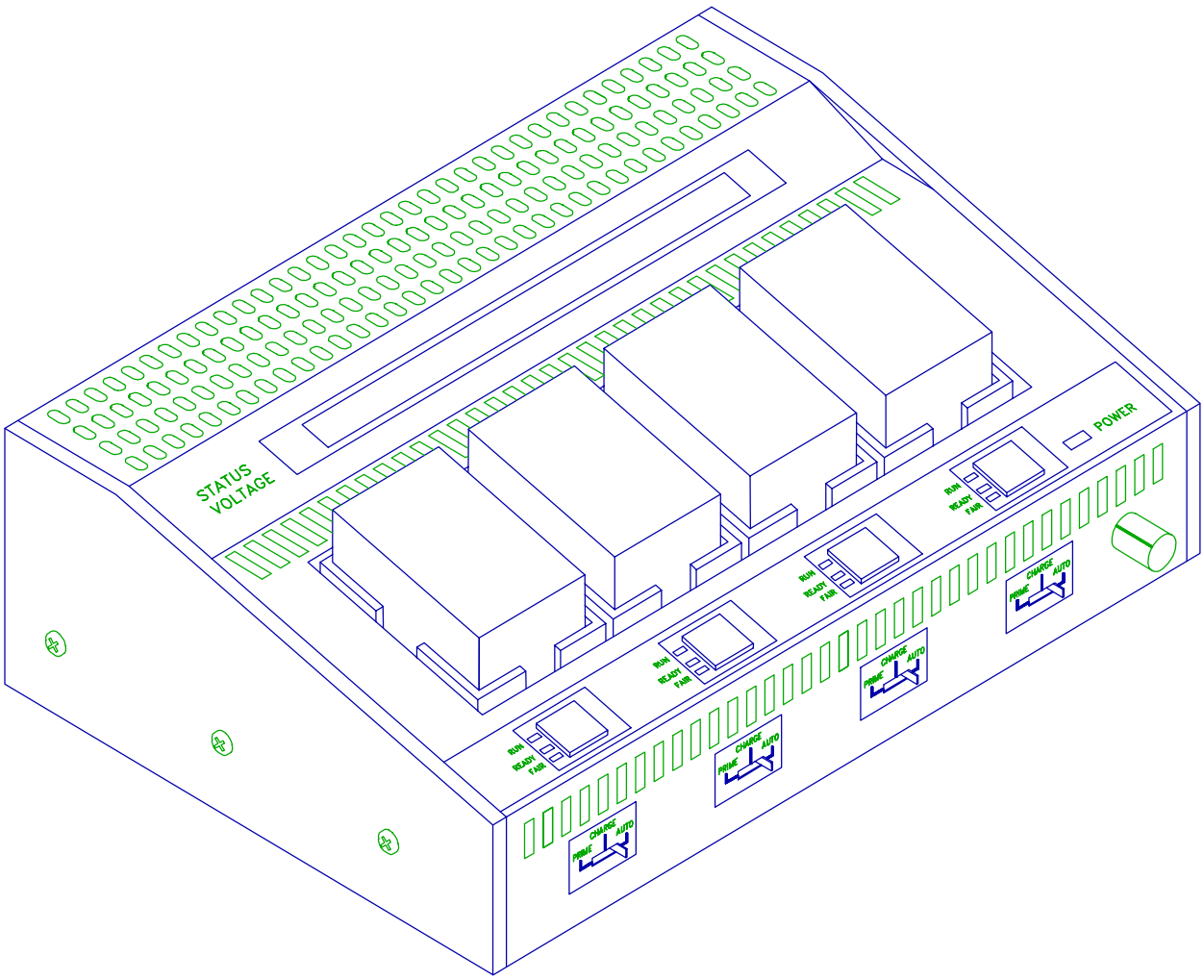


Figure B3-3. Battery Reconditioner

Table B3-3. Battery Reconditioner

Figure & Index No.	Part Number	CAGE	Description 1 2 3 4 5 6 7	Units per Assy	Usable on Code	SMR Code
B3-3	R2000	43678	Battery Reconditioner..... (23386/SS-1600320-1) (SPEC CTRL DRW) (see T.O. 31R2-2PRC139-3 for breakdown)	0001		PADDDT

Section III. NUMERICAL INDEX

Part Number	Figure & Item Number	Part Number	Figure & Item Number	Part Number	Figure & Item Number
GDC-2A	B3-2-1				
218001	B3-2-2				
R2000	B3-3				
SS-4100846-501	B3-1				
SS-4100885-501	B3-2				

Section IV. REFERENCE DESIGNATION INDEX

This section is not applicable.

Section V. COMMON BULK ITEMS LIST

Part Number	CAGE Code	Description	Unit of Measure
FIT-221-3/4 Clear	92194	Insulation Sleeving, Shrink (23386/595002-750-C)	A/R
M23053/05-105-C	81349	Tubing Shrinkable .093/.046 PO (23386/595002-750-C)	A/R
No 222 50CC	05972	Threadlocking Compound No. 222 (23386/91172)	A/R

APPENDIX C

COMMUNICATIONS SECURITY (COMSEC) INSTRUCTIONS

ORGANIZATIONAL LEVEL

RADIO SET AN/PRC-139 (C)

CHAPTER C1 INTRODUCTION

C1-1 CONTENTS.

This publication provides general and detailed descriptions, installation instructions, operation instructions, principles of operation, maintenance instructions, and parts information for the AN/PRC-139(C).

C1-2 RELATED PUBLICATIONS.

The effective edition of the following publication may be used as reference material in connection with this manual.

Manual	Title
T.O. 31R2-2PRC39-1	Operation and Maintenance Instructions with Illustrated Parts Breakdown. Organizational Level. Radio Set AN/PRC-139(C)
T.O. 31R2-2PRC139-3	Operation and Maintenance Instructions with Illustrated Parts Breakdown. Depot Level. Radio Set AN/PRC-139(C)

C1-3 QUALIFICATIONS FOR MAINTENANCE PERSONNEL.

C1-3.1 Full Maintenance Personnel.

Personnel performing installation, maintenance, or repair of COMSEC equipment must be qualified in accordance with the criteria established by NSTISSI 4000 or department and agency directive and regulations, as applicable. These include:

Department of Defense - DoD Instruction 4660.2
U.S. Air Force - Air Force Instruction 21-109

C1-3.2 Limited Maintenance Personnel.

Personnel who have completed formal training on the limited maintenance of the equipment may perform only those procedures specified in the effective edition of the Limited Maintenance Manual and are not authorized to perform higher levels of maintenance.

C1-3.3 COMSEC Equipment Exchange Personnel.

Any properly cleared personnel may, if authorized by the department or agency controlling operational use of the equipment, remove the equipment from its operating position and replace it with another. This procedure is limited to disconnecting and reconnecting the cables going to the equipment and the physical exchange of the equipment. Maintenance other than equipment exchange may be performed only by personnel who have been formally trained and certified to perform higher level maintenance.

C1-4 MODIFICATION OF EQUIPMENT.

A modification is any electrical, mechanical, or software change which may or may not affect the characteristics of any NSA-approved COMSEC item. The four classes of modifications are Mandatory Modifications, Optional Modifications, Special Mission Modifications, and Repair Actions.

NOTE:
No modification/alternation shall be made to COMSEC equipment without prior official approval by the National Security Agency.

C1-5 TEMPEST CONSIDERATIONS.

TEMPEST is an UNCLASSIFIED term referring to investigations and studies of comprising emanation: such as unintentional, data-related, or intelligence-bearing signals which, if intercepted and analyzed, would disclose the classified information being transmitted, received, handled, or otherwise processed by the information-processing equipment. The equipment has been designed to contain these emanations within safe limits. Operations and maintenance personnel must observe the following precautions in order to maintain the TEMPEST integrity of equipment.

a. The covers must always be in place and firmly secured by all mounting screws when processing operational or exercise traffic. It is only permissible to operate the equipment with the covers removed when maintenance or test keys are being used and no operational traffic is being processed.

b. No test leads may be attached or remain attached to the equipment when operational or exercise traffic is being processed.

c. No attempt may be made to bypass filtering designed into the equipment.

d. No substitution with unauthorized components, particularly those that pertain to TEMPEST protection, shall be made.

e. Interfacing equipment must present prescribed signal levels and impedance to all lines, as indicated in the electrical specifications.

C1-6 COMSEC INSECURITIES.

Any occurrence which subjects any Controlled Cryptographic Item (CCI) or classified COMSEC material to possible compromise must be reported immediately to the Director, National Security Agency, ATTN: X712, and to the appropriate service, departments, or agency authorities. Reports of possible compromises at contractor facilities must be submitted and subsequent investigations conducted in accordance with the requirements of DoD 5220.22-M and DoD 5220.22-S-1. Any suspicious or unusual occurrences should be reported immediately. The following security-related incidents are reportable in accordance with NTISSI 4003, dated 3 November 1986, and applicable service, department, or agency instructions.

C1-6.1 Cryptographic Insecurities.

(1). Use of COMSEC keying material which is comprised, superseded, defective, previously used and not authorized for reuse, or in any way incorrect for the cryptoperiod or application in which it is used. For example:

(a). Unauthorized use of any key for other than its intended purpose.

(b). Use of key which was produced locally without the authorization of the Director, National Security Agency.

(c). Unauthorized extension of a cryptoperiod.

(d). Premature use of key.

NOTE

Failure to zeroize a common fill device within the required time should be reported as a physical security violation.

(2). Use of cryptosystem, or a cryptosystem operating practice or maintenance practice, which is not approved by the Director, National Security Agency. For example:

(a). Operational use of a COMSEC equipment without completion of a required alarm-check test or after failure of a required alarm-check test.

(b). Actual or attempted maintenance of a COMSEC equipment by unqualified personnel.

(3). Use of COMSEC equipment having defective cryptographic logic circuitry. For example:

(a). Plaintext transmission resulting from a COMSEC equipment failure or malfunction.

(b). Any transmission during or after an uncorrected failure that may cause improper operation of a COMSEC equipment.

(4). Discussions, ia unprotected telecommunications, of the details of a crypto-equipment failure or malfunction.

(5). Tampering with, or unauthorized modifications of, a COMSEC equipment or system.

(6). Compromising emanations from a COMSEC equipment.

(7). Any other occurrence which may have resulted in a cryptographic insecurity.

C1-6.2 Personnel Insecurities.

These include actions and circumstances involving persons with access to COMSEC material, which have jeopardized, or could jeopardize, the security of COMSEC material. Examples of such actions and circumstances are:

(1). Known or suspected defection, espionage, hostile cognizant agent activity, treason, sabotage, or capture by an enemy or persons who have detailed knowledge of cryptographic logic or uncontrolled access or keying material.

(2). Theft of COMSEC material.

(3). Deliberate falsification of COMSEC records.

(4). Unauthorized disclosure of information concerning COMSEC material or attempts by unauthorized persons to effect such disclosure.

C1-6.3 Physical Insecurities.

(1). The physical loss of COMSEC material, including a portion(s) thereof (for example, a CCI equipment or a classified page from a COMSEC maintenance manual).

(2). COMSEC material discovered outside of required COMSEC accountability or physical control. For example:

(a). COMSEC material reflected on a destruction report as having been properly destroyed and witnessed, but found not to have been destroyed.

(b). COMSEC material left unsecured and unattended where unauthorized persons could have access.

(3). COMSEC material improperly packaged, shipped, or destroyed. For example:

(a). COMSEC material received in a damaged package.

(b). Destruction of COMSEC material by other than authorized means or COMSEC material not completely destroyed and left unattended.

(4). COMSEC material received in a package which shows evidence of tampering, or known or suspected tampering with COMSEC material at any time..

(5). Unauthorized access to COMSEC material.

(6). Failure to zeroize a common fill device within the required time.

(7). Premature opening of a sealed package of keying material.

(8). Unexplained loose key cards in a package having a wideband seal.

(9). Unauthorized copying, reproducing, or photographing of COMSEC material.

(10). A clandestine intercept or recording device discovered in or near a COMSEC facility.
(11). Any other incident which jeopardized the physical security of COMSEC material.

C1-6.4 Special Reportable Occurrences.

(1). Any instance where maintenance personnel discover what they believe may be an inherent weakness of the

equipment circuitry or operation and any repetitious failures that may warrant a modification to the equipment. The report shall include a complete history of such failures.

C1-7 SAFEGUARDING THE EQUIPMENT.

The equipment described in this manual and its associated equipment will be handled and accounted for by each department or agency in accordance with the regulations governing the handling of CCI, and unclassified material.

C1-8 SECURITY CLASSIFICATION.

The unkeyed Radio Set AN/PRC-139(C) is Controlled Cryptographic Item (CCI). When keyed the Radio Set AN/PRC-139(C) is classified to the same level as the key. The Crypto Circuit Card Assembly (CCA) is the only CCI CCA in the equipment.